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Semiconductor Crystal Experiment Performed

LD1411102889 Moscow World Service in English 0800 GMT 14 Nov 89

[Text] On board the Soviet orbital complex Mir the cosmonauts manning it have concluded another experiment aimed at growing semiconductors. This involved a large installation which made it possible to obtain trial consignments of superclean crystals. The entire process was automatic. Cosmonauts Aleksandr Vitorenko and Aleksandr Serebrov only monitored the experiment. In conditions of space it is possible to obtain semiconductors unobtainable by terrestrial technology. These materials are indispensable in electronics.

D Module Scheduled For 26 November Launch

LD1611054389 Moscow TASS in English 1743 GMT 15 Nov 89

[Text] Moscow November 15 TASS—The launch of an equipment module to link up with the Mir orbiting station has been scheduled for November 26 from the Baikonur launch site.

This will be a second attempt to put the module into space. The first launch was aborted by a last minute command of the onboard computer which found a fault in the electronic docking system.

In October, the system, "Kurs," was taken off the module and sent to the factory where it had been made, for improvements.

Officials from the USSR Ministry of General Machine Building told TASS that the improved automatic docking stysem, which has withstood a series of trials, "is now ready for operation."

After the first two days of testing, long before the end of the full testing cycle, experts concluded that the system was in order.

The module is now being prepared for launch in accordance with the pre-launch schedule.

By November 17, the module's propulsion system will be loaded with fuel components. Then it will be attached to a proton booster rocket and taken to the launch pad on November 21.

Before November 25, the work with the module and the booster rocket will continue on the pad, and the rocket will be fuelled.

Further Details on D Module

LD1611072189 Moscow TASS in English 0711 GMT 16 Nov 89

[Text] Moscow November 16 TASS—A module to re-equip the Mir space station is scheduled to blast off on November 26, officials of the Chief Administration for the Development and Use of Space Engineering for the Economy and Research told TASS.

A Proton booster rocket will put the module into orbit in 10 days' time and then it will dock with the Soviet long-time space complex.

The re-equipment module has an air lock chamber for space walkouts and other equipment for work in outer space, including a "space bike" for a cosmonaut's independent movements.

Designers baptised the "bike" "Icarus". It has a fly-away umbilical cord, although an independent power supply system enables the "bike" to move in space without it.

The module also has equipment to retool the complex as well as fuel, water and food.

Cosmonauts Aleskandr Viktorenko and Aleksandr Serebrov who are working for the third month aboard the Mir station, are waiting for the module. It will considerably expand the range of research.

As it was reported earlier, some changes have taken place in the program of the current mission aboard the Mir station. The re-equipment module was to be launched in mid-September.

However, the launching was put off, since some malfunctions in the Kurs system were detected during ground tests. The Kurs system will put the module into a pre-set orbit and ensure its rendezvous with the station.

Cosmonauts Continue Research Program Aboard 'Mir'

LD1711212389 Moscow TASS in English 1118 GMT 17 Nov 89

[Text] Moscow November 17 TASS—By TASS correspondent from the Mission Control Center:

Cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov will conduct a series of geophysical experiments aboard the Mir space station on Friday to study the atmosphere.

The research will be conducted with the help of an electronic photometer that measures the brightness of stars as they set over the earth's horizon.

In the afternoon, the cosmonauts are scheduled to conduct the "Resonance" experiment to determine the scope and character of micro accelerations in the movement of the space complex and gauge its dynamic characteristics.

The crewmen will continue astrophysical research under the Roentgen international program.

On Satuday, orbital telescopes will focus on a roentgen pulsar in the Aquarius constellation.

In the past two days, the cosmonauts have conducted technnical and astrophysical experiments and maintenance of the life-support system. The space stations orbit was corrected with the help of power plants of the cargo ship.

The flight is proceeding normally. Both cosmonauts are healthy and feel well.

'Mir' Cosmonauts Perform Observations for UNESCO Program

LD2111120289 Moscow TASS in English 1133 GMT 21 Nov 89

[Text] Moscow November 21 TASS—By TASS correspondent: Aleksandr Viktorenko and Aleksandr Serebrov continue their space mission.

The crew of the Mir space complex have completed another series of experiments, the aim of which was to explore the structure of the Earth's atmosphere and determine its optical characteristics.

On instructions from specialists who take part in the work on the UNESCO international program "Man and Biosphere", the cosmonauts carried out several series of observations and photographed biospheric preserves in various parts of the world.

Under a plan of preventive maintenance, the crew replaced a purification unit in the system of water regeneration from atmospheric moisture.

The cosmonauts are today placing used equipment in the ferry "Progress M". They also plan to fulfil astrophysical experiments with the magnetic spectrometer "Mariya".

During the day the station's propulsion engine will be refuelled with an oxidizer on orders from the Mission Control Center.

Work at the station proceeds according to schedule. The cosmonauts feel well.

Final Preparations For Module Launch

LD2511165489 Moscow TASS International Service in Russian 0524 GMT 25 Nov 89

[Text] Moscow 25 Nov (TASS)—The launch of the module, which will deliver further equipment to the Soviet long-duration 'Mir' orbiting station is preliminarily set for 1600 Mosow time [1300 GMT] on 26 November, the TASS correspondent was told in the USSR Glavkosmos [Main Administration for the Development and Use of Space Technology for the National Economy and Scientific Research].

So, only 24 hours remain before the module is put into space by the "Proton" carrier rocket. Aleksandr Viktorenko and Aleksandr Serebrov, who are working for their third month on the 'Mir' orbiting complex, have been impatiently waiting this. Indeed, there is equipment in the module for further supplying the complex, which will allow the program of scientific research to be significantly extended. It is equipped with a lock chamber to allow the cosmonauts to go out into open space and have everything necessary for working there. So, a 'space bicycle,' a unit allowing the cosmonaut to move about autonomously, know as the 'Ikar' will be delivered into space. In the module are also supplies of water, fuel, and food.

The docking with the 'Mir' complex, which has been in space since February 1986, is planned for December.

It has twice been necessary to change the time of the launch of the equipment modul; the first time was in April because of delays in preparing the modul. The decision was made to use the station without a crew, in order to economize resources and better prepare for the new stage of work of 'Mir.'

It was necessary to move the date of the launch, planned for the middle of September because a certain unreliability of individual elements was discovered in the course of the ground tests in the 'Kurs' system, which ensures that the module goes into the given orbit and approaches the station. Careful checks and tests were required before the specialists certified that the renewed system of automatic docking was ready for use.

Today the last preparation for launch are proceeding.

Launch of D Module Announced

LD2611172189 Moscow TASS in English 1551 GMT 26 Nov 89

[Text] Moscow November 26 TASS—By TASS special correspondent:

A re-equipment module of the Soviet Mir orbital space station was fired off from the Baykonur Cosmodrome at 16:01, Moscow time, today. It is being put into orbit by Proton booster rocket.

It is planned that the module will dock with the Mir complex which has been in space since February 1986, on December 2, 1989.

Aleksandr Viktorenko and Aleksandr Serebrov working at the Mir orbital station for the third month, are impatiently waiting for the module, since it carries instrumentation for re-equipment of the station, which will enable them to expand considerably the research program.

It has an air lock chamber for cosmonauts' space walkouts and other equipment to work there. The module will bring a "space bike" called Ikar, a vehicle for cosmonauts' independent movements in space. The module also has water, fuel and foodstuffs.

The module's launching was put off two times. The first time it was in April due to a delay in manufacturing the

module. It was decided to operate the station without a crew to save funds and to prepare better for a new stage in the station's work.

The second launching scheduled for mid-September was put off due to the fact that some unreliability in the operation of several components was detected in the Kurs system putting the module into a pre-set orbit and its rendezvous with the station during ground tests.

The system was painstakingly tested at the factory, before specialists became convinced that the improved system of automatic docking was ready for operation.

Solar Panel Fails To Open on 'Kvant-2' Module

LD2611211689 Moscow TASS International Service in Russian 1915 GMT 26 Nov 89

[Excerpts] Kaliningrad (Moscow Oblast), 26 Nov (TASS)—TASS correspondent reports from the Flight Control Centre. [Passage omitted]

The launching and liftoff of the heavy module took place without a hitch. However, after the 'Kvant-2' separated from the carrier, it was established from telemetric information that one of the solar panels had not fully opened. After a brief prompt meeting a decision was made to repeat the command to open the solar panel during the next communication session. We waited for the beginning of the communication session. The digital board of the Flight Control Center lit up: Entering the zone was to start at 1755. The module finally entered the zone. The experts worked with precision in the 'Kvant-2' control room. The command to open the solar panel was issued at the moment of 'Kvant-2' passing over the northern part of the Caspian Sea. But the equipment at the Flight Control Center failed to transmit the information. The telemetric data confirmed once more that the solar panel in the fourth plane did not fully open.

Of course, the failure of the solar panel to open fully is not fatal for 'Kvant-2.' In principle after the docking of the module with the complex, the cosmonauts can start working on it during one of their space walks, although the final decision is up to those who are in charge of the flight. But for the moment, the experts are trying to fully open the panel with the aid of the resources aboard at the order from earth. [passage omitted]

'Kvant-2' Orbital Parameters

LD2611191189 Moscow TASS International Service in Russian 1803 GMT 26 Nov 89

[Text] Moscow, 26 Nov (TASS)—The specialized 'Kvant-2' module, with a mass of about 20 tonnes, was launched in the Soviet Union into near-earth orbit today by a 'Proton' carrier-rocket in accordance with the space research program.

The module is intended for upgrading the 'Mir' orbital station with additional equipment and apparatus to substantially expand research and experiments carried out in the interest of science and the national economy.

The on-board systems of the module: Orientation and movement control with the use of power gyroscopic stabilizers, electricity supply, and life support systems with improved equipment for the regeneration of water and to obtain oxygen, will be switched into the general circuit of the orbital complex. This will increase the efficiency of its use and reduce the traffic of expendable materials being delivered from earth.

The scientific apparatus of the module was developed by specialists from the Soviet Union, Czechoslovakia, and the GDR.

The orbit parameters of the specialized module are:

- maximum distance from the earth's surface: 339 km;
- minimum distance from the earth's surface: 221 km;
- a period of revolution: 89.3 minutes;
- inclination: 51.6 degrees;

The docking of the 'Kvant-2' module and the manned 'Mir' complex is planned for 2 December.

'Kvant-2' Module Measurements

LD2611191989 Moscow Domestic Service in Russian 1258 GMT 26 Nov 89

[Summary] The 'Kvant-2' module weighs 19,565 kg, its maximum length is 13.73 meters, and its maximum diameter is 4.35 meters. The maximum volume of all its compartments is 59 cubic meters. The module will orbit for six days before docking with 'Mir.' It will then be transfered to another docking bay.

'Kvant-2' Systems Shut Down To Conserve Energy

LD2711181489 Moscow TASS in English 1804 GMT 27 Nov 89

[Text] Moscow November 27 TASS—The Soviet space module Kvant-2 is now in its second day of flight. it is to add to the Mir orbital space complex some additional equipment and instruments to broaden the scope of research and experiments carried out in the interests of science and the economy.

The cargo delivered by the Kvant-2 contains fuel as well as food and water for Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov who continue their work in orbit.

According to telemetric information received from the module during the first communications session, one of the two panels of the solar battery has failed to unfold completely.

Flight Control Center officials told TASS that attempts to open the solar battery using the module's onboard equipment controlled from earth have so far failed. Flight control specialists have switched off some of the module's systems to "save its energy resources".

'Kvant-2' Orbital Corrrection Performed

LD2911214689 Moscow TASS International Service in Russian 1912 GMT 29 Nov 89

[Text] Moscow, 29 Nov. (TASS)—TASS correspondent reports from Flight Control Center:

In accordance with the flight program, the planned operations for correcting the orbit of the 'Kvant-2' module have been carried out today. Before these works began, the altitude of the module was monitored in space and there was a controlled switching on of its engine. The dual-impulse maneuver of rendezvous with the 'Mir' manned complex was carried out at the caluclated time.

After the correction, the parameters of the module's orbit accord with those calculated and are:

—apogee—413 km;
—perigee—344 km;
—period of revolution—91.8 mins;
—orbital inclination—51.6 degrees.

Standard tests of the working regime of the "Kurs" radiotechnical rendezvous and docking system are planned for 30 November.

'Kvant-2' Second Solar Panel 'Fully Opened'

LD3011213589 Moscow TASS in English 2132 GMT 30 Nov 89

[Text] Flight Control Center, December 1 TASS—Preparations for the specialised Kvant-2 module to link up with the manned Mir complex are continuing. The Kurs radiotechnical approach and link-up system were verified in different regimes of work on Thursday.

According to the telemetric information, the module's systems are functioning normally. The efficiency of the power supply system has been restored—the second panel of the solar battery fully opened.

The Kvant-2 module orbit will be corrected on December 1, in accordance with the program, for continued approach and link-up with the Mir complex.

Destructive Reentry of 'Progress M'

LD0112150189 Moscow TASS in English 1434 GMT 1 Dec 89

[Text] Moscow December 1 TASS—A Soviet program to test a modified unmanned spaceship of a new series, Progress M, has been completed and the craft was sent to the dense layers of the atmosphere where it burned up.

The spacecraft, placed in orbit on August 23, delivered to the Soviet manned space station Mir ("Peace") more than two tonnes of cargo.

The flight path of the orbital research complex was adjusted using the propulsion units of the freight craft.

Progress M undocked from the station at 12:02 Moscow time today. It was programmed to follow a descent trajectory, entered the dense layers of the atmosphere and ceased to exist.

The cosmonauts Alekandr Viktorenko and Aleksandr Serebrov are continuing their work on board the Mir station. According to the results of a medical check-up, they are in good health.

In keeping with the flight program, the special module Kvant-2 and the manned complex Mir were maneuvred closer to each other. According to telemetry information, the on-board systems of the two spacecraft are functioning normally.

'Kvant-2'-'Mir' Docking Postponed To 6 December

LD0212164989 Moscow TASS International Service in Russian 1634 GMT 2 Dec 89

[Text] Flight Control Center, 2 Dec (TASS)—The docking of the 'Kvant-2' module with the Mir orbital complex, which was scheduled for today, has not taken place due to a malfunction in one of the module's automatic control systems. It has been decided to carry out the docking of the space vessels on 6 December.

Two adjustments were made to the module's trajectory today to enable it to rendezvous with the Mir orbital complex.

Commentary on 'Kvant' Problems

PM0112115389 Moscow KRASNAYA ZVEZDA in Russian 29 Nov 89 First Edition p 3

[Colonel M. Rebrov report: "'Kvant-2': Complex Situation"—first two paragraphs are TASS report]

[Text] Mission Control Center, 27 Nov—During the past 24 hours of the flight of the specialized "Kvant-2" module the on-board telemetry it has transmitted has been processed and analyzed. The situation that emerged due to the incomplete deployment of one of the solar panels has been modeled and the spacecraft's dynamic characteristics have been clarified. The necessary ground experiments to elaborate the sequence of Mission Control operations have also been put in place.

The module's flight conditions have been precisely defined on the basis of the data obtained.

Mission Control Center, 28 Nov—Worries arose after the launcher's final-stage boosters were switched off and the "craft" was placed in orbit. During this period the automatic monitoring systems "interrogate" everything that should be "opening," "moving forward," "slowing," "starting up," or "shutting down" and transmit the data to earth by telemetry. That was how the signal arrived from space that one of the solar panels had not fully opened.

The report was brief and merely stated the fact itself. But what did it indicate, how would this situation affect the rest of the 'Kvant-2' mission and, above all, its docking with 'Mir?' There were many questions. What position was the panel in? How was the backup power pack working? Would there be enough power to work all the systems involved in the docking procedure? How would the flight dynamics change? What should the orientation be?

For the rest of the day and night after the launch and for the following 24 hours the Mission Control Center worked flat out. Analyzing the information coming in from the instruments, the specialists concluded that in all probability the panel was covering part of the engine used to control the module's position. It was also established that the power balance was falling. An extremely complex situation was taking shape.

People sought the only correct solution out of the many seemingly logical and possible solutions. Through calculation and modeling it proved possible to select a solar orientation mode [rezhim orientatsii na Solntse] without starting up the "shrouded" engines. An essentially delicate operation had to be carried out so as to prevent additional complications. With the greatest caution and after considerable doubts attempts were made to start up the actual engines which had been accidentally "covered up"....

That night those present at the Mission Control Center monitored proceedings in a tense silence. By the morning of 28 November the telemetry brought the important report that there was a positive power balance!

This means that the backup power pack had worked and was close to normal. This means that it is possible to hope that subsequent work will be carried out successfully. But it still does not mean that all the difficulties and problems are over. The automatic docking software stored in the computer memory is based on certain dynamic spaceflight characteristics which have now changed. Recalculations, new models, and highly accurate solutions are needed.

In short, the fate of 'Kvant-2' now depends on the professionalism of those controlling the module's flight, the equipment's reserve potential, and the precise and timely implementation of all operations.

I have been observing the Mission Control Center's work during the past tense 24 hours, and I have heard the specialists' comments—these were severe, unambiguous, and restrained, but optimistic. I very much believe that they will resolve this highly difficult task, although I repeat that the situation is very complex.

Docking Attempt on 2 December Terminated

LD0312125989 Moscow TASS in English 1234 GMT 3 Dec 89

[Text] Moscow December 3 TASS—By TASS correspondent from the Mission Control Center:

An adjustment of the flight path of the Kvant-2 module was made at 12:38 Moscow time today to put it into a new orbit on target to dock with the Mir station on December 6.

An analysis of telemetric data has shown that following the double-impulse maneuvre on December 2 to adjust the module's orbit, the module automatically locked on a course to rendezvous with the Mir orbital complex.

However, the parameters of the mutual movement of the spacecraft at this stage went beyond the required allowance ensuring the necessary docking conditions. The approach process was automatically cut off in accordance with the accepted logic of the operation.

All systems of the Kvant-2 module and the Mir orbital station are functioning normally.

'Kvant-2'-'Mir' Docking Set for 6 December

LD0512114589 Moscow World Service in English 0800 GMT 5 Dec 89

[Text] Mission Control of the Soviet space module "Kvant-2" is preparing for another attempt to dock it with the orbiting station "Mir".

Our correspondent reports that the sophisticated operation is expected at 12 hours 20 minutes UTC tomorrow [6 December].

The first attempt last Saturday failed. Electronic devices halted the approach of the multiton apparatus at a distance of 20 kilometers. All the systems of the module and the station are functioning normally. The crew of the "Mir" station, Viktorenko and Serebrov, are preparing to receive the new lab.

TASS Reports 'Kvant-2' Docking With 'Mir' Station

LD0612141189 Moscow TASS in English 1350 GMT 6 Dec 89

[Text] Moscow December 6 TASS—By TASS correspondent Rena Kuznetsova:

The module Kvant-2 docked with the Mir manned station today at 15 hours 21 minutes Moscow time [1221 GMT]. The supply module was put into orbit on November 26 by a Proton carrier-rocket.

The vehicle was badly needed by cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov who have already spent three months on board the Mir station. It brought the crew life-sustaining and research equipment which will allow them to expand the research programme.

The module is provided with an air lock through which the cosmonauts will be able to step out into open space and with everything necessary for their work there, including an Icarus "space bicycle" on which the cosmonauts will be able to move independently in outer space. It has also brought them water, fuel and food supplies.

The supply module's launch had to be postponed twice, first in April due to delays in its construction. A decision was taken to leave the space station unmanned for several months to save money and to prepare more thoroughly for a new phase of operation.

The launch date was altered again in mid-September because some faulty elements were found during ground tests in the Kurs system ensuring the module's correct orbiting and closing in with the station. Careful factory checks and tests were carried out before it was decided that the repaired automatic docking system was ready for use.

There were difficulties this time too. It was learned after the launch that one of Kvant's solar panels was jammed. The fault was successfully corrected, however. The module could not be docked on December 2 and the operation was rescheduled for today.

Further Report on Docking

LD0612174689 Moscow TASS in English 1731 GMT 6 Dec 89

[Text] Moscow December 6 TASS—The special-purpose module Kvant-2 docked with the manned orbital complex Mir at 15:22 Moscow time today [1222 GMT FBIS].

The mutual search, rendezvous, mooring and docking of the two spacecraft were conducted in an automatic mode.

The processes were monitored by Mission Control Center, the command and measurement complex and cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov, working on board the Mir station.

The module Kvant-2 docked with the orbital station from the transfer unit side.

The total mass of the manned complex comprising Mir, Kvant, Kvant-2 and Soyuz TM-8 is 63 tonnes, its length is 40 meters.

Due to a number of problems that emerged during the module's flight to the Mir station, experts of leading research and design institutions were also employed in order to work out possible options.

After analysing and modelling the situation on computers and conducting tests on ground-based facilities, the specialists determined the best modes in which to conduct the dynamic operation that ensured the link-up of the spacecraft.

Next Friday, the module will be moved to its assigned position, one of the side docking points on the basic unit.

'Soyuz TM-8' Redocked at 'Mir' Transfer Compartment

LD1212111789 Moscow TASS in English 1020 GMT 12 Dec 89

[Text] Moscow December 12 TASS—By TASS special correspondent Rena Kuznetsova:

The Soyuz TM-8 cargo spacecraft was today successfully moved from the Kvant astrophysical module to the transfer compartment of the basic module of the manned orbital complex Mir.

The operation was carried by the Mission Control Center with due regard for the further provision of the station with the necessary materials and equipment that are periodically delivered to orbit by Progress automatic spacecraft.

The third-generation orbital station Mir in its design and technical equipment considerably surpasses its predecessors—Salyut stations.

The Mir is fitted out with a new docking system with six docking assemblies and constitutes a basic module for the construction of a versatile permanently functioning manned orbital complex with specialised orbital modules of scientific and economic purpose.

The basic module has six docking assemblies, two of which—axial—are used for the docking of spaceships and research modules while the four lateral ones are intended for the permanent positioning of research modules.

The Mir complex will have a total of five specialised modules and its mass will amount to 130 tons.

Important operations to dock the Kvant-2 module, the mass of which is 20 tons, with the orbital complex Mir, and then to move the module to its permanent working place were carried out on December 6 and 8.

With the addition of the Kvant-2 module to the orbital complex, the living and working conditions of the cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov became more comfortable in their "two-storey orbital home", staff at the Mission Control Center told TASS.

Previously they also had all the necessary conditions for living and working and for sports exercises. This time they have received an installation for the production of oxygen and regeneration of water.

Scientists point out that the specialised module has considerably expanded resources for research and experiments for the benefit of various branches of the Soviet economy.

Cosmonauts Hold Press Conference

LD1412180789 Moscow TASS in English 1616 GMT 14 Dec 89

[Text] Moscow December 14 TASS—By TASS correspondent Rena Kuznetsova:

Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov today began their hundredth day in space. It is an ordinary working day: medical investigations, astrophysical observations and physical training.

A "spacecraft talking to Earth" press conference was held in the Flight Control Centre, during which journalists could interview crew members.

The journalists were perhaps interested most of all in the cosmonauts' transport vehicle, a tiny spaceship delivered to the Mir complex by the Kvant-2 module. Serebrov was even offended when the TASS correspondent mentioned a "space bicycle." It is not a "bicycle," the engineer on board quipped, it is a "motorcycle": for it has its autonomous engine enabling the cosmonaut to operate for six hours near the orbital complex, (?maneuvering around) the orbital complex.

The mission's deputy chief Viktor Blagov told journalists that the first space walk is scheduled for February 1, 1990, to be resumed five days later. The present crew plans five space walks.

The crew members readily showed journalists their premises as well as the Inkubator-2 biotechnical complex to study the growth of birds in zero gravity.

A group of Soviet journalists vying for the participation in a space mission are now undergoing medical checks at the Medicobiological Problems Institute of the USSR Ministry of Public Health.

The cosmonauts were asked about their attitude to a reporter's participation in a space flight.

"We welcome the appearance of a journalist in the spaceship," Viktorenko replied. "However, it is desirable for him to be a specialist in some field. Otherwise he'll be bored by the flight."

The cosmonauts noted that, while working on the spaceship, they do not forget about issues concerning the Soviet people and are closely following the work of the 2nd Congress of People's Deputies.

Viktorenko and Serebrov Complete 100 Days in Space

LD1512114189 Moscow TASS in English 1137 GMT 15 Dec 89

[Text] Moscow December 15 TASS—By TASS special correspondent from the Mission Control Center:

Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov have now spent one hundred days in space. After the redocking of the cargo craft, the crew continues to reactivate the Kvant-2 module.

There are a considerable amount of systems and equipment, alongside scientific instruments, aboard the re-equipment module. They will be switched into the general circuit of the Mir Station.

To do this, the cosmonauts connected in the past two days power units of the module, the main block and the systems, collecting and transferring telemetric information to Earth.

Today the crew will prepare a new "Elektron" installation, which is an element of the system, ensuring the correct gas composition of the station's atmosphere, and will be used to receive oxygen through water electrolysis.

The cosmonauts feel well. The flight of the Mir station is proceeding normally.

Cosmonauts To Perform Five EVAs

LD1912223189 Moscow TASS in English 2154 GMT 19 Dec 89

[Text] Moscow December 19 TASS—By TASS Correspondent Rena Kuznetsova:

An unmanned cargo spacecraft is scheduled for launch in the Soviet Union on Wednesday at 06:31 Moscow time, an official from the Mission Control Center told TASS.

Progress M-2 will dock with the Mir orbital station. The cargo it will bring to cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov will include foodstuffs and water and a 40-kilogram parcel with New Year presents.

The expedition on the orbital station will last until February 19, the official said.

During the remaining period, the cosmonauts plan five spacewalks. On February 1, they will try a "space motorcycle," a vehicle for moving in outer space.

During the spacewalks, Viktorenko and Serebrov will install star sensors and a cosmic ray detector outside the station and remove samples of materials left by a Soviet-French expedition.

Deputy Mission Head Viktor Blagov said Mir is yet to host three modules—technological, optical and international environmental ones. The latter is planned to be launched in mid-1991.

There are also plans for international space expeditions. Japanese and Britons are now training with Soviet cosmonauts at the Soviet Space Center near Moscow. In January 1990 they will be joined by Austrians.

'Progress M-2' Launched 20 Dec

LD2012045889 Moscow TASS International Service in Russian 0405 GMT 20 Dec 89

[Text] [No dateline as received] In accordance with the program for the further work of the "Mir" scientific research complex, the "Progress M-2" automatic cargo craft was launched in the Soviet Union at 0631 hours Moscow time [0331 GMT] on 20 December 1989.

The aim of the launch of the spacecraft is to deliver expendable materials and various cargoes to the "Mir" manned complex.

According to telemetric data, the on-board systems of the automatic cargo craft are functioning normally.

Update on Work Aboard 'Mir' Orbital Station

LD2612140689 Moscow TASS in English 1337 GMT 26 Dec 89

[Text] Moscow December 26 TASS—A TASS correspondent reports from the Flight Control Center:

The 16th week of Aleksandr Viktorenko's and Aleksandr Serebrov's orbital flight is drawing to a close.

The crew will install a new set of storage batteries, brought by the Progress M-2 freight spaceship, and replace separate automatic elements in the power supply system today, in accordance with the Mir station maintenance program.

While unloading the freight vehicle, the cosmonauts continue implementing the scientific part of the flight's program. Zinc oxide monocrystals are to be obtained on the Gallar unit in conditions of microgravitation through smelting.

The freight spaceship brought scientific equipment, made in the United States and designed, in accordance with a commercial agreement, for space biotechnological experiments. The cosmonauts switched on the equipment on December 23.

Biotechnological experiments under the Soviet scientific research program began the same day.

According to the telemetric information and the crew's reports, all systems aboard the Mir complex are funcitoning normally.

The work in the near-earth orbit is proceeding according to schedule.

Cosmonauts Preparing For First EVA

LD2912152189 Moscow TASS in English 1505 GMT 29 Dec 89

[Text] Flight Control Centre December 29 TASS—Cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov are completing the last working week in the outgoing year aboard the orbital scientific research complex Mir.

In the past two days Viktorenko and Serebrov carried out experiments in space materialogy and biology and attended to maintenance of the equipment aboard the complex. Both had a medical check-up with the use of the pneumo-vacuum "Chibis" suit which imitates gravity.

The flight program provides for a considerable volume of work in open space, including on the exterior surface of the basic compartment and orbital modules. The first walk in outer space is planned to be held early in January 1990.

The cosmonauts are preparing the necessary equipment. They reactivated their space suits and are checking the functioning of their systems today.

According to the results of the medical check-up, Aleksandr Viktorenko and Aleksandr Serebrov are in good health.

The flight of the manned complex Mir is proceeding normally.

Cosmonauts Continue Materials Experiments

LD0201113990 Moscow TASS in English 1131 GMT 2 Jan 90

[Text] Mission Control Center January 2 TASS—Cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov, who are making a space flight on board the Mir space research complex, continued technological experiments and astrophysical studies today, and prepared the equipment needed for a space walk.

The melt started at the Gallar installation on December 26 is ending. Its purpose was to obtain a semiconductor material with improved characteristics in conditions of microgravitation.

The systematic measurement of the flows of elementary charged high-energy particles in near-Earth space continues with the help of the Mariya magnetic spectrometer.

The cosmonauts are continuing experiments designed to further the study of the impact of outer space factors on various materials. Samples of polymer and composite materials, as well as units of radioelectronic equipment, are used in these studies.

According to telemetric information and reports from the orbit, the flight of the Mir space complex is proceeding normally. Both cosmonauts are in good health.

Cosmonauts Perform 3-Hour Space Walk

LD0901025290 Moscow TASS International Service in Russian 0045 GMT 9 Jan 90

[Text] Flight Control Center, 9 Jan (TASS)—In accordance with the flight program of the Mir scientific research complex, Aleksandr Viktorenko and Aleksandr Serebrov have carried out an extravehicular activity. The main aim of the extravehicular activity was to mount two star sensors intended to increase the accuracy of the complex's control system.

On 8 January at 2323 Moscow time [2023 GMT], the cosmonauts opened the external hatch of the transfer compartment and went out onto the station's exterior surface.

The crew took the equipment and the instruments necessary for the assembly into the work area in the scientific instrument compartment of the Kvant astrophysical module. Then the cosmonauts installed the stellar sensors on standard points and connected them to the general circuits of the on-board automatic equipment of the orbital complex.

From the exterior surface of the station, the commander and the flight engineer dismantled test-pieces of various materials which had been exposed for a long time in conditions of open space.

After the completion of the planned work, the cosmonauts returned to the station. The crew were in open space for a total period of 3 hours.

Aleksandr Viktorenko and Aleksandr Serebrov are in good health and feel fine.

Mir Crew Prepares For Second EVA

LD1001123890 Moscow Domestic Service in Russian 0700 GMT 10 Jan 90

[Text] The lengthy orbital flight of the crew of the Mir scientific research complex is continuing. Today, Aleksandr Viktorenko and Aleksandr Serebrov are making preparations for a second space walk. In the course of the day they will check the systems on their space suits and make ready the equipment and the instruments with which they will work on the external surface of the station.

Within the framework of a wide-ranging program of biological research, a three-day research period has been carried out on the development of flax in conditions of an artificial magnetic field, using the Magnitogravistat installation. An experiment also has been completed to study the growth of lettuce in weightlessness.

According to the crew's reports and telemetric data, the flight is proceeding according to the designated program. Both cosmonauts are in good health and feel fine.

Cosmonauts Perform Second EVA 11 Jan

LD1101232390 Moscow TASS in English 2250 GMT 11 Jan 90

[Text] Moscow, Mission Control Center, January 12, TASS—The crew of the Mir orbital complex completed another stage of work in raw space. The main tasks to be accomplished on the outer surface of the Mir complex during their second walk in space were the installation of new research devices and the removal of the panel with samples of construction materials fixed there in December 1988 during the flight of the Soviet-French crew.

Aleksandr Viktorenko and Aleksandr Serebrov got out into space through the hatch of the station's coupling unit at 21:01 Moscow time on January 11.

The cosmonauts fixed cassettes with samples of nonmetallic materials onto the outer surface of the station and the Arfa ["Harp"] equipment for the further investigation of the earth's ionosphere and magnetosphere onto the Kvant astrophysical module. After that the crew dismantled the panel with samples of materials and the register of micrometeorite flows. They also removed the ramp that was used for unfolding the girder structure under the Soviet-French ERA experiment program.

Having concluded planned work on the outer surface of the station. The flight commander and the mission engineer returned to the coupling section to prepare it for the docking of a specialised module due to arrive soon. The cosmonauts removed the docking unit from the spot where the Kvant-2 module was docked and fixed it onto the opposite corner unit. After that they shut the entrance hatch.

The crew spent a total of 2 hours 54 minutes in raw space.

The flight of the Mir complex continues. Aleksandr Viktorenko and Aleksandr Serebrov are feeling well.

Crew Complete 130 Days Aboard Mir

LD1601125790 Moscow TASS in English 1240 GMT 16 Jan 90

[Text] Moscow January 16 TASS—The TASS correspondent reports from Mission Control Center: Alexandr Viktorenko and Alexandr Serebrov have now spent 130 days aboard the Mir orbital complex. Following the completion of operations related to the spacewalk, they continued to fulfil the flight program.

They performed a new experiment in space materials studies on the Gallar installation. Its purpose was to grow a monocrystal of gallium arsenide using the method of oriented crystallisation.

Under the schedule of checking and maintenance work, the cosmonauts replaced a set of hydraulic pumps in the station's thermoregulation system.

Today the crew is engaged mostly in reactivating a sanitary and hygienic support system in the Kvant-2 service module. In the evening they plan to correct the complex's orbit by using the tanker transport vehicle's engines.

According to telemetry and reports from orbit, the flight is proceeding normally. Both cosmonauts are in good health and feel well.

Mir Cosmonauts Planning 26 Jan Spacewalk

LD1801095290 Moscow TASS in English 0804 GMT 18 Jan 90

[Text] Moscow January 18 TASS—Aleksandr Viktorenko and Aleksandr Serebrov, who have now entered their fifth month aboard the Mir space station, are again preparing for a space walk. Officials of the Flight Control Center told TASS that it is scheduled for January 26.

Previous space walks took place on January 8 and 11. The cosmonauts set a record by walking 35 meters away from their "orbital home." All in all, the commander and flight engineer stayed outside the spaceship for about six hours.

The third walk will not be the last. They will make other space walks on February 4 and 5 when they will ride a "space motorbike." This vehicle will enable a cosmonaut to maneuver around the spaceship and to a distance away from it.

Aleksey Leonov was the first man in the world to walk in space. He did this 25 years ago. Svetlana Savitskaya was the first woman to walk outside a spaceship. French cosmonaut Jean-Loup Chretien stepped into space out of the Soviet Mir orbital complex in 1988.

Mir Cosmonauts Perform Third EVA 26 January

LD2601192990 Moscow TASS in English 1907 GMT 26 Jan 90

[Text] Moscow January 26 TASS—Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov, who have been working aboard the Mir space complex for almost five months, today took their third spacewalk. They used the airlock compartment of the purpose-built Kvant-2 module.

The principal goals of the spacewalk were to assemble additional scientific equipment on the exterior surface of the service module and test the spacesuits.

Viktorenko and Serebrov began their work in outer space at 15:09 Moscow time [1209 GMT]. In the area of the exit hatch they assembled a special docking device which will later be used during the work to install the "space motorcycle." For more convenience in carrying out the planned operations in outer space, the crew removed one of the antennas of the radio-technical system Kurs from the Kvant-2 module.

The cosmonauts then installed a television camera on the platform, which is designed for geophysical research. The spacemen assembled units of the Ferrit and Danko equipment and two cassettes with specimens of miscellaneous materials on the compartment for scientific instruments to study the characteristics, physico-mechanical properties and structure of materials exposed to space.

During the walk the spacemen also checked the operation of the autonomous radio communications systems and telemetry of the spacesuits and inspected the exterior elements of the Kvant-2 module structure.

All in all, Viktorenko and Serebrov spent three hours and two minutes in space.

Before completing their mission, the cosmonauts plan to take another two spacewalks.

Austrian Cosmonaut Candidates Arrive for Training

LD0801182990 Moscow TASS in English 1801 GMT 8 Jan 90

[Text] Moscow January 8 TASS—Two Austrian citizens hoping to participate in a mixed space mission aboard the Soviet complex Mir, arrived from Vienna to Moscow today. They are Doctor Clemens Lothaller and Franz Vienboeck.

From the Sheremetyevo Airport, they were driven to the Gagarin Cosmonaut Training Center near Moscow, where Soviet cosmonauts and their families live and work. The Austrian hopefuls will train at the Center for the coming flight which is scheduled for 1991.

It is planned during the joint Soviet-Austrian flight to carry out several scientific investigations and experiments in space medicine, physics, materials science and sounding of the earth in the interests of the Austrian economy.

In the near future it is planned to conduct a TV linkup with the participation of the Soviet crew working aboard the Mir complex and the Austrian candidates. It will be broadcast to both countries.

TASS learned at the Cosmonaut Training Center that the Austrians would devote the first months of their stay at the centre to studying the Russian language.

Japanese and British candidates for international space missions are now training at the Center.

Details on 'Granat' Space Project

LD3011213889 Moscow TASS in English 2056 GMT 30 Nov 89

[Text] Moscow November 30 TASS—An astrophysical observatory, "Granat", is scheduled to be launched into outer space from the Baykonur Cosmodrome at 11:21 p.m., Moscow time, on December 1.

A Proton carrier-rocket will first deliver the space vehicle to an intermediate artificial earth satellite orbit. Then, in the first revolution, after switching of the fourth stage propulsion units, it will be changed over to a working orbit.

The aim of the experiment is to explore sources of X-ray and gamma emissions in the universe. Neutron stars, black holes, white dwarfs, remains of supernova star eruptions, the centre of our galaxy as well as its interstellar medium and extra-galaxy objects are to be explored.

The background X-ray emission of the universe and its properties as a whole are also to be explored. Construction of images and revealing of the structure in nuclei of active galaxies is of great interest, specialists believe. The study of variable sources of small-energy X-ray and gamma eruptions will be carried out with the help of the Soviet instrument Podsolnukh (Sunflower). It is a set of telescopes installed on a revolving platform along with a video information registration unit.

The Granat observatory scientific equipment was designed by scientists and specialists of the Soviet Union, France, Bulgaria and Denmark.

Solar batteries (with) silicon photo-transformers are used as a source of electric energy. A steady radio communication of the space vehicle with earth will be ensured by low-gain receiving-transmitting antennae in decimeter and centimeter ranges, installed on the orbital module.

The ART-P and Sigma telescopes, designed respectively by Soviet and French specialists, will make it possible to obtain images of X-ray emission sources in a broad range of energies. The observatory's scientific equipment also includes a traditional ART-C astronomic X-ray telescope.

'Granat' Astrophysical Observatory Launched

Launch Announcement

LD0112205789

[Editorial Report] Moscow Domestic Service in Russian at 2018 GMT on 1 December carries a live report from Baykonur about the launch of the "Granat" observatory. Radio correspondents Bezyayev and Lazarevich report that the Proton rocket carrying the observatory was launched at 2021 GMT, according to schedule. They add that the rocket is only carrying a load of 4 tonnes, but is taking a lengthy trajectory in order to avoid the pull of the earth.

Further Details

LD0112213289 Moscow TASS in English 2120 GMT 1 Dec 89

[Text] Moscow December 1 TASS—An astrophysical observatory "Granat" was launched from the Baykonur Cosmodrome by a "Proton" carrier-rocket today.

The "Proton" carrier-rocket will initially deliver the space vehicle into an intermediate artificial earth satellite orbit, and then, in the first revolution, after the fourth stage propulsion units are switched on, it will be changed over to a working orbit.

The aim of the experiment is to study sources of x-ray and gamma-emission in the universe. Neutron stars, black holes, white dwarfs, remains of supernova star eruptions, the center of our galaxy and also its interstellar medium and extra-galaxy objects will be explored.

The "Granat" scientific equipment was designed by scientists and specialists from the Soviet Union, France, Bulgaria and Denmark.

Orbital Parameters Given

LD0212035589 Moscow TASS International Service in Russian 0212 GMT 2 Dec 89

[Text] [No dateline as received] At 2321 hours [2021 GMT] Moscow time on 1 December the Granat orbital observatory was launched in the Soviet Union by a Proton carrier rocket. The Granat international project provides for research into space sources of X- ray and mild gamma radiation.

The Granat orbital observatory, weighing four tons, was created at the S.A. Lavochkin Scientific Production Association of the USSR Ministry of General Machine-Building with the involvement of many of the country's design and industrial enterprises. It has on board scientific equipment created by scientists and specialists of the Soviet Union, France, Denmark, and the People's Republic of Bulgaria.

The Granat orbital observatory has been put into a high elliptical orbit of an earth satellite with the following parameters:

—maximum distance from the earth's surface (at the apogee) 200,000 kilometers;
—minimum distance from the earth's surface (at the perigee) 2,000 kilometers;
—initial period of revolution 98 hours;
—orbital inclination 51.6 degrees.

During the flight the ground stations of the Soviet Union's command and measurement complex will receive the scientific information coming from the orbital observatory and convey it to the Space Research

Institute of the USSR Academy of Sciences for subsequent processing and distribution among the scientific institutes and laboratories of the USSR, France, Denmark, and Bulgaria taking part in the project.

Research Program Outlined

LD0212124389 Moscow TASS in English 1230 GMT 2 Dec 89

[Text] Moscow December 2 TASS—The astrophysical observatory Granat was launched into space from Baykonur cosmodrome by a Proton booster rocket at 2320, Moscow time, [2200 GMT] on Friday.

The Proton booster rocket at first ensured the delivery of the spacecraft to an intermediate orbit of the Earth's satellite. Then, during the first orbit, upon firing the engines of the fourth stage, it moved to a working orbit.

The principle purpose of the experiment is to research into x-ray and gamma-ray radiation sources in the universe. The objects of research include neutron stars, black holes, white dwarfs, the remains of supernova flare-ups, the center of our galaxy and its interstellar medium and extragalactic objects.

The program also envisages research into the background X-ray radiation of the universe and its properties as a whole.

The plotting of images and the revelation of structure in the nuclei of active galaxies is of great interest, experts believe.

The study of variable low-energy sources of x-ray and gamma-ray flare-ups—yet another purpose of the project—will be carried out by means of the Soviet instrument Podsolnukh (Sunflower). The instrument is a set of telescopes which are mounted on a rotating platform together with the videoinformation registration unit.

The scientific equipment of the Granat observatory was designed by scientists and specialists of the Soviet Union, France, Bulgaria, and Denmark.

Solar cell batteries with silicon photoconverters are used as the source of electric power. The spacecraft's radio contact with the Earth will be ensured by means of low-directional transceiving antennas of the decimeter and centimeter wavebands installed on the orbital module.

The Art-P and Sigma telescopes, designed by Soviet and French specialists respectively, will make it possible to receive the images of x-ray radiation sources with a broad range of energies. The scientific equipment of the observatory also includes the traditional astronomical Art-S x-ray telescope.

To Function 8 Months

LD0212152689 Moscow TASS in English 1446 GMT 2 Dec 89

[Text] Moscow December 2 TASS—The Granat space observatory launched from the Baykonur Cosmodrome on the night of December 1 to 2 is designed to function for eight months but may continue to operate much longer.

A major international project, Granat was created in the Soviet Union in close cooperation with specialists from France, Denmark, and Bulgaria. The scientific equipment includes seven telescopes that provide more than twenty "eyes" for space research.

The space observatory carries instruments to study gamma flares of cosmic radiation and other equipment. The overall weight of research equipment is 2.3 tonnes.

The orbital observatory will study various neutron stars and "black holes", the remains of supernova flares, the interstellar medium of the Milky Way and the center of the galaxy.

Extragalactic objects—intergalactic gas in the clusters of galaxies, quazars, the nuclei of active galaxies, and radio galaxies—are also of interest to researchers.

The background X-ray radiation of the universe will be studied and "weak" sources will be counted.

Research(ers) do not rule out that the Granat may provide new scientific data that will change our notion of the universe and of some processes taking place in it.

The service systems of the Granat must be checked and tuned, and scientific equipment will be calibrated and tested before December 15. The first data on the observation of the universe will then begin coming in from orbit.

'Lomonosov' Astronomy Satellite Project Detailed

LD2912102889 Moscow TASS International Service in Russian 0920 GMT 29 Dec 89

[Text] Moscow, 29 Dec (TASS)—TASS correspondent Rena Kusnetsova writes:

Soviet scientists have started drawing up the "Lomonosov" global space astronomical project. Within its framework it is proposed to launch a Soviet space observatory in 1995 or 1996. Yevgeniy Sheffer, a leading staff member of the Shternberg Astronomy Institute, reports that the "Lomonosov" project's aim is to create a high precision coordinate system of the entire sky, which could function over a period of 30-50 years.

This task can be resolved only as a result of comprehensive work: A space experiment—the observation of stars by means of a telesecope installed on board an artificial earth satellite—will become the basis of this work, the scientist said. This will make it possible to avoid the

distortions, which are so inherent in astronometric observations, conducted through the atmosphere. With a view to providing the backup on earth for the space research, it is intended to create a catalogue of 400,000 stars and other celestial objects under special programs.

Of all the technical novelties and contemporary methods, the scientist noted, it is only the astronomy satellite which is for the first time giving scientists the real hope of constructing a uniform reading system for the whole celestial sphere which would be considerably more accurate than those in existence today.

Yevgeniy Sheffer stressed that the fundamental significance of the "Lomonosov" project comprises of creating a coordinate system for scientific and practical aims, and also of the receipt of information. In particular, a long-term system of coordinates, so necessary for terrestrial astrometry, geodynamics, geodesy, and the study of the solar system will be established.

The Soviet scientist recalled that the "Hipparcos" astronomy satellite was launched on 8 August this year by the European Space Agency in order to resolve analogous tasks. It is proposed that Soviet astronomers will, in the future, compare data received from these two projects. This will allow errors which may exist in either of the projects to be uncovered and eliminated, and both programs also to be mutually embellished and enriched.

UDC 523.12

Analytical Model of Evolution of Protoplanetary Accretion Disk

18660211 Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 23 No 2, Apr-Jun 89 (manuscript received 18 May 87, after revision 14 Jun 88) pp 125-133

[Article by A. D. Grechinsky, Space Research Institute, USSR Academy of Sciences]

[Abstract] The analytical model formulated by P. Cassen, et al. (ICARUS, 48, No 3, pp 353-376, 1981) enabled qualitative research on the evolution of the protoplanetary disk, but it assumed that all the matter accreted on the disk falls in the immediate vicinity of the core. A study was therefore made to ascertain what effects the accretion of matter directly onto the disk has on the results obtained by Cassen, et al. The researchers here set out to construct and study a model that would make it possible in the approximation of low angular momentum to describe the evolution of the protoplanetary disk based on such accretion. Expressions are derived which can be used in computing evolution of the accretion disk for any values of angular momentum, mass and viscosity. With respect to temperature distributions on the disk, they are virtually identical for all P values and coincide with the distributions obtained by T. V. Ruzmaykina, et al. (ASTRON. VEST., Vol 20, No 3, pp 212-227, 1986) and P. Cassen, et al., although in determining the temperature distribution no allowance was made for disk heating due to emission of a protostar, and therefore the temperature may actually be greater. The picture of evolution differs qualitatively and quantitatively from that obtained by the mentioned authors. In any case, the accretion of matter exerts a considerable influence on disk parameters and evolution. Figures 2; references 6: 1 Russian, 5 Western.

UDC 524.337

Optical Observations of X-ray Nova in Constellation Vulpecula (ASM 2000+25) in July-November 1988

18660213a Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 7, Jul 89 (manuscript received 28 Nov 88, after revision 5 Apr 89) pp 611-616

[Article by Ye. P. Pavlenko, V. V. Prokofyeva and A. I. Dolgushin, Crimean Astrophysical Observatory, USSR Academy of Sciences, Nauchnyy Village]

[Abstract] An X-ray nova (ASM 2000+25) in Vulpecula was discovered by the Japanese Ginga spacecraft in April 1988 and was identified with a star of $17^m.5$. During the period July-November 1988 optical observations were made using the 0.5 m meniscus telescope at the Crimean Astrophysical Observatory. The following photometric features of emission of the object were registered in the optical range of the spectrum during the mentioned period: a decrease in brightness of the object at the rate $0^m.016$ per day in the time interval from July through September; slowing of the rate of brightness decrease, and possibly its stoppage in October; a mean rate in the entire observation interval of $-0^m.013$ per day; presence of quasiperiodic brightness fluctuations with a characteristic time 8-9 days with an amplitude about $0^m.1$; presence of regular brightness variations with a period of about $0^d.348$, with a brightness curve somewhat different from a sine curve and with a variable amplitude averaging $0^d.11$. The observations give evidence of a duality of the system and a nonstationary nature of the processes that take place in it. The color index of the nova for 4-8 August was B-V = $1^m.2$. Figures 5; references 8: 4 Russian, 4 Western.

UDC 523.4

Jovian Seismology

18660213b Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 7, Jul 89 (manuscript received 24 Mar 89) pp 646-653

[Article by S. V. Vorontsov, T. V. Gudkova and V. N. Zharkov, Earth Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] The structure and diagnostic properties of the spectrum of natural oscillations of models of Jupiter are examined. It is shown that the spectrum is extremely sensitive to the properties of the inner core and to abrupt changes in density in the interior of the planet. The low-frequency region of the theoretical spectrum of oscillations in adiabatic models of Jupiter contains "fractured" modes of oscillations concentrated at the discontinuity points. The recording of these oscillations should yield information on the regions of variation in chemical composition and on the hydrogen metallization boundary. The periods of low-frequency oscillations may be subject to the strong influence of rotation effects. High-frequency oscillations (approx. 3 mHz) have a high diagnostic capability with respect to study of structure of the central regions of Jupiter. Their recording should be highly valuable for determining the size and structure of the inner core. It is shown that asymptotic theory is inapplicable for investigating the high-frequency part of the acoustic spectrum; from the very beginning, any quantitative study of the theoretical spectrum of oscillations in modern models must be based on direct numerical computations. Figures 5; references 11: 7 Russian, 4 Western.

UDC 531.31+523.25+523.47

Uranus System, Solar System and Wave Astrodynamics. Theoretical Prediction and Observations by Voyager 2 Spacecraft

18660085 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 303 No 5, Dec 88 (manuscript received 5 Jun 87) pp 1082-1088

[Article by A. M. Chechelnitskiy]

[Abstract] In the natural sciences there is increasing understanding that not only objects of the microworld, but also objects of the megaworld, must be examined from a unified point of view and in a dynamic context, particularly within the framework of wave dynamic systems. It is from this point of view that the article investigates the solar system as a wave dynamic system; a corresponding examination is made for the Uranus system. Theoretical predictions are compared with Voyager 2 observations. A table lists large satellites, multiplets of satellites and dominant (strong) orbits of the Uranus system. A special scheme gives the dynamic structure of the solar system and satellite systems of solar system planets prepared on the basis of wave dynamic system concepts. The various hypotheses outlined in this article seem to be supported by the Voyager 2 experimental data and have definite prognostic value. Figure 1; references 10: 3 Russian, 7 Western.

UDC 523.43

Polar Wandering on Mars: Evidence and Implications

18660212 Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 23 No 2, Apr-Jun 89 (manuscript received 7 Apr 88) pp 99-124

[Article by P. H. Schultz, Geology Department, Brown University, Providence, R.I.]

[Abstract] The thick deposits of atmospheric origin situated near the present-day areographic poles were formed in the relatively recent geological history of Mars. Similar but more ancient deposits are found in the differing geology and relief encountered on opposite sides of the planet, near the Mesogaea-Amazonis and Arabia regions. The high rate of erosion and its nature within the boundaries of these deposits suggest the existence in these areas of easily movable, ice-enriched deposits of atmospheric origin that are responsible for the formation of typical relief features, including pedestal craters, remnants of stratified deposits within nearby craters, and pourous, banded terrain. Since local accumulations of such thick deposits of atmospheric origin are unique for present-day polar conditions, it can be postulated that deposits in the Mesogaea and Arabia regions are evidence of polar environments which have changed with time as a result of polar wandering. This possibility is confirmed by the nature of distribution and orientation of meteor impact craters formed with low impact angles. These craters may be attributable to collision with Phobos-like satellites that were at one time revolving around the planet in equatorial planes. There is evidence that the principal shifts in the areographic poles corresponded to a transition from an early moon-like volcano-tectonic appearance to the more recent eruptive stage which resulted in the formation of large volcanic structures. Changes in planetary moment of inertia were responsible for polar wandering in ancient epochs. Figures 12; references 32 (Western).

Biotechnology in Orbit

907Q0009a Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 89 pp 3-6

[Article by A. P. Aleksandrov, candidate of engineering sciences, USSR pilot-cosmonaut, two-time recipient of title of Hero of the Soviet Union, under the rubric "Cosmonautics": "Biotechnology in Orbit"; first paragraph is ZEMLYA I VSELENNAYA introduction]

[Text]An extensive program of space biotechnology was carried out aboard the Salyut and Mir orbital stations, and the first semi- commercial samples of biological products have been obtained in weightlessness.

As we know, earth's population is constantly growing. Hundreds of thousands of years were needed for the population to reach a billion by the first 25 years of the last century, there were 2 billion of us in another 100 years, and according to demographers there will be more than 8 billion by the year 2025.

The increase in population imposes special demands on science and engineering. Mankind must primarily be supplied with food. This means that new highly productive varieties of plants, breeds of animals will have to be developed, and methods will have to be elaborated to protect them against various diseases.

At the same time, the adverse effects of industrial activity of mankind on the environment makes it mandatory to develop new industrial technologies capable of efficiently converting the waste from man's technological activities to natural constituents of the environment. These tasks also include development of ecologically clean biological methods of intensifying agriculture.

The advances made in the last few decades in the field of biology in developed countries have led to appearance of a new scientific-engineering direction on the borderline of biological and engineering sciences—biotechnology, and it is to solve many problems facing mankind.

Why Is Biotechnology Needed?

One of the most pressing tasks for biotechnology is **to develop effective and safe biologicals for the prevention and treatment of diseases.** Basically new types of vaccines, diagnostic and therapeutic sera can be developed by biotechnological methods, and they can also be used to improve significantly previously known products free of deleterious side-effects due to the fact that they will be highly purified.

Let us list the very pure biologicals needed for development of medicine and other sectors of the national economy.

Medicine needs interferon and interleukin for treatment of various severe infectious and malignant diseases, blood proteins, blood-clotting factors, human growth hormones, insulin for treatment of diseases of the blood, burns, ulcers and genetic diseases; monoclonal antibodies for recovery of scarce protein preparations, as well as detection of immune and malignant diseases.

Agriculture needs vaccines, therapeutic agents, hormones and other products for intensification of animal development, new, highly effective varieties of plants and highly active biological pesticide producers.

The food industry needs enzymes and microorganisms to produce foods using a new technology, food supplements, vitamins, etc.

For development of natural resources, microorganisms are needed for biological adsorption of petroleum, and highly active microorganisms that produce organic compounds from industrial waste.

Biotechnological processes based on various physicochemical phenomena in liquid media are used to obtain products of biological origin and to study their properties. Some of these processes are much more efficient in weightlessness, during spaceflights.

Methods of Processing Biological Material

Various biotechnological processes are being considered among the future methods of processing biomaterial in space. For example, three possible directions of practical implementation of space biotechnology are being studied in the United States:

electrophoretic separation of biological mixtures;

biosynthesis of substances;

investigation of biological dynamics of cells.

Some of these biotechnological processes have not yet been tested in an actual flight; however, electrophoretic and protein crystallizing processes, which have been experimentally tested in space, are rated as very promising.

Conditions on the ground limit significantly productivity and purity of separation of substances, and the extent of technological loss of biomaterial. For this reason, the potential gain from moving such industries into space is very high. Already the first inflight experiments carried out by Soviet and American cosmonauts have shown that one can increase **by hundreds of times** the productivity of electrophoretic installations and **by several times** (for some methods **tens of times**) the purity of recovered proteins.

With the development and refinement of biotechnology, the list of products to be obtained in space will be constantly updated, but it will always include the most valuable and most important biological systems. Production in space not only of substances that are extremely labor-intensive on the ground, but products that are manufactured on earth with limited purity may become promising and economically justified (in the opinion of specialists). This applies in particular to cells, separation

"Ruchey" [stream] installation for fine purification of genetically engineered interferon

of which on the ground is of minimal effectiveness or impossible, and proteins recovered by genetic engineering methods.

The difficulty of purification of gene-engineering products to remove numerous impurities of bacterial proteins is the principal barrier that is retarding the use of these new and effective drugs in health care practice. The chromatographic methods existing on the ground for fine purification of proteins are extremely expensive and, moreover, they can cause change in structure and properties of the proteins to be purified. For this reason, **electrophoretic**, highly productive methods of purifying protein preparations in a microgravity environment may become an alternative to the ground-based methods.

Electrophoretic Biotechnology in Space

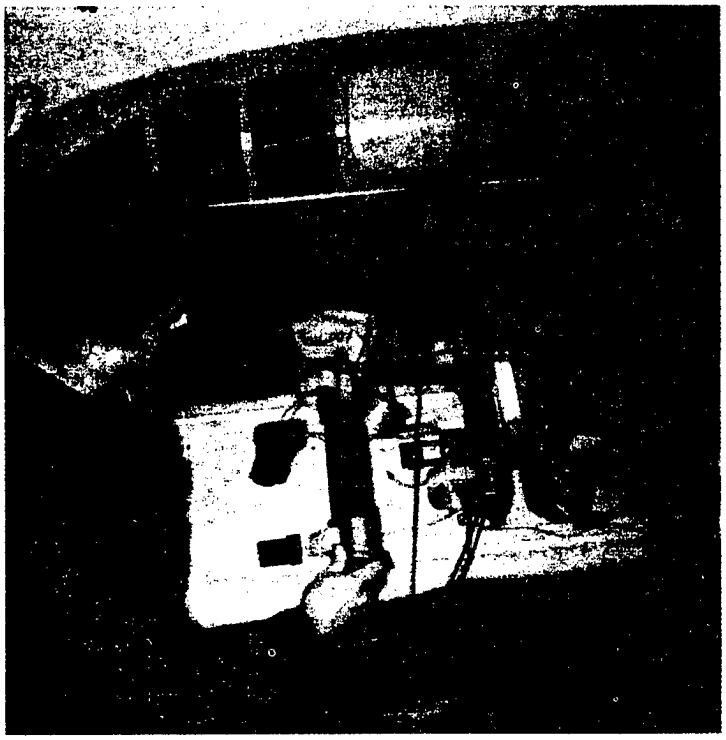
Experiments exploring the capabilities of electrophoretic methods of separating biological substances in space began in 1971-1972 aboard the Apollo series of spacecraft; then they were continued aboard the Skylab station and in 1982 during the Space Shuttle flights. At the present time, other highly developed countries, including France, FRG and Japan, are also showing interest in producing biologicals in space.

The first Soviet experiments on electrophoresis of proteins of animal blood and cells were carried out in 1982 aboard the Salyut-7 station (cosmonauts L. I. Popov, A. A. Serebrov and S. Ye. Savitskaya) on the Tavriya device. Experiments of interest to the national economy as well were started on the same Tavriya installation in 1983 by V. A. Lyakhov and A. P. Aleksandrov. At that time, the crew removed allergenic impurities on electrophoretic columns from a protein preparation of hemagglutinin produced from the membranes of influenza viruses. This work had been ordered by the Institute of Epidemiology and Microbiology imeni L. Pasteur and the Crimean Medical Institute. Pure hemagglutinin was necessary for production of antisera against influenza that would not cause side-effects, as well as a standard of purity for this drug. The fractions of purified hemagglutinin obtained in the experiment retained their biological activity and were very pure: the concentration of allergenic impurities was 25-50 times lower in them than in series-produced influenza vaccines for adults.

The results of this work found a practical application. Hemagglutinin fractions have been used to produce antisera against influenza, which have passed a factory test when used to check the purity of series-produced influenza vaccine at the Leningrad Institute of Vaccines and Sera, and they have been used for three years in research.

Subsequently, experiments dealing with purification of new patches of influenza vaccines aboard the Salyut-7 station were continued on an updated Tavriya device in 1984 (V. A. Dzhanibekov, S. Ye. Savitskaya and I. P. Volk) and the automated Efu-Robot unit (V. V. Vasyutin, V. P. Savinykh and A. A. Volkov) in 1985.

Some results of scientific interest and practical importance were obtained in space with electrophoretic separation of microorganisms that produce antibiotics for livestock. These experiments were also carried out aboard Salyut-7 (Tavriya and Efu-Robot devices) and the Mir complex (in the Quantum module) on the automated Svetlana installation. In these experiments, fractions containing highly active species of microorganisms, superproducers with the capacity to manufacture 35-40 percent more tilozin and flavomycin than the originally bred strain, were isolated from cell suspensions of microorganisms that produce these antibiotics. The superproducers isolated in space are now used in the breeding work of the "Biotechnology" All-Union Scientific Research Institute.



A. Aleksandrov using the Tavriya unit to remove allergenic impurities from a protein preparation to be used for influenza antisera

In July 1987 (ZEMLYA I VSELENNAYA, 1988, No 2, p 3—ed.), **experimental-industrial** biotechnological experiments on a new Ruchey [stream] flow-type electrophoretic unit were performed on the Mir complex (A. S. Viktorenko, A. P. Aleksandrov and M. Faris) during a Soviet-Syrian mission. The research program included testing and refinement of modes for basic technological processes of highly productive fine purification of protein drug products, as well as testing an installation the operating principle of which is based on a more promising electrophoretic method.

A layer of buffer solution, into which the initial biological preparation was delivered in a fine jet, moved continuously across the high-tension electric field in the separation chamber of the Ruchey unit. Under the effect of the electric field, the charged molecules of different proteins moved at different speeds toward opposite walls of the chamber, to the poles. At the exit from the chamber, the separated fractions passed into special sealed vials of the fraction collector, which were then rapidly delivered to the ground.

Final (fine) purification of small batches of human interferon obtained by genetic engineering was performed in experiments on the Ruchey to remove microbial proteins that remained after commercial production. In addition, separation of human blood proteins was studied: hemoglobin and albumin with protein concentrations in the initial specimen that were 50 times higher than used for electrophoresis on the ground.

In the course of ground-based computer processing of video patterns of electrophoretic processes, data were obtained about the actual characteristics of dynamics and quality of protein separation in microgravity. The unit was 280 times more productive than under ordinary conditions. The high purity of separated proteins and fractions of interferon confirmed the conclusions of specialists that purification and separation of biologicals in space are efficient.

In the next experiments carried out by V. G. Titov and M. Kh. Manarov in 1988, there was almost **1000-fold** increase in productivity of the electrophoretic unit, and not only were impurities removed from interferon fractions, but also biologically inactive forms of interferon, which has not been feasible on earth thus far.

These are the practical results of only one of the directions of space biotechnology, electrophoresis of biological objects. On their basis, existing methods and technological processes are being improved and new ones developed for purification and isolation of valuable biologicals, determination is being made of the basic designs for high-power commercial biotechnological systems to be operated in space.

Training In Space

907Q0009b Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 89 pp 7-12

[Article by G. I. Antonov, candidate of psychological sciences, Institute of Psychology USSR Academy of Sciences, and V. N. Kubasov, candidate of engineering sciences, USSR pilot-cosmonaut, two-time recipient of title of Hero of the Soviet Union, under the rubric "Cosmonautics": "Training ... in Space";first paragraph is ZEMLYA I VSELENNAYA introduction]

[Text]The duration of spaceflights and complexity of research programs executed by cosmonauts are increasing with each year. Safeguarding their health, increasing the crew's work capacity and effectiveness of research carried out aboard manned vehicles depend not only on ground-based cosmonaut training, but to an ever increasing extent on inflight training.

Approach to Mars

Dear readers, please imagine that it is the start of the 21st century. The terrestrials' spacecraft is approaching the cherished target of its mission, the mysterious "red planet" Mars. Behind them is a 9-month flight from the orbit of earth's satellite. The distance between the spacecraft and earth is already about a hundred million kilometers. The delays in radio communication with the control center now exceed 10 minutes, and in case of an emergency the crew can only rely on the craft's systems, their own knowledge, skill and experience. Now the craft enters into the orbit of a Mars satellite. The crew starts to prepare for undocking of the landing module and for the landing on the planet's surface. The cosmonauts are worried. How will the automated equipment work? They have to be ready to replace it if there is a malfunction during the descent and landing. Such situations have occurred. During the flights to the moon on the Apollo program, the equipment malfunctioned more than once. It is only the great professional skill of P. Stafford aboard Apollo-10 and N. Armstrong aboard Apollo-11 that saved the situation. The many hours of ground-based astronaut training were not in vain. Does the crew have enough knowledge and skill now? After all, the last training sessions on the simulators at the training center, where the descent and landing operations were learned, were so long ago.

Important operations have begun, which require more intense monitoring on the part of the cosmonauts. What is on the crew's mind? The situation resembles the first training sessions. The flow of information is overwhelming the cosmonauts, they cannot spread their attention over all of the important parameters, and only part of them are fixed in their immediate memory. They are unable to integrate different parameters into an image of the current status of the craft. The instrument readings conceal an idea about the real displacements of the landing module in space. They are unable to mentally anticipate development of a situation onboard, yet such anticipation played the main role at the start of the mission in detecting deviations in equipment function. Now they are relying more on the signals emitted about malfunction by automation itself. Well, if such a signal does appear they will have to react instantaneously and without error. But the actions refined on simulators to the point of automatism cannot be performed now without prior mental gauging, additional and deliberate self-monitoring. Fine coordination of movements, which is necessary for manual control of the craft, has been lost. They have to make trial movements to remove doubts; accuracy of visual assessment of parameters of propulsion of the space vehicle, velocity and altitude of flight has also diminished. No, in such a condition it is hard to expect appropriate actions in the event of malfunction in the automated control circuit. The clear and integral mental image of the forthcoming mission, which had been formed after long hours of training on earth and which successfully controlled the cosmonauts' actions in the most difficult situations, has faded to an inadmissible level due to the long period since it was used.

Drawing on Experience

Have we exaggerated in describing such a prospect? Is it so realistic? Are there instances of such a loss of skills by cosmonauts? Yes there are; analysis of the results of long-term spaceflights aboard Soviet orbital complexes gives us grounds to worry about an inadmissible decline of some professional skills.

For example, analysis of erroneous actions of crew members of the Salyut-6 and Salyut-7 stations revealed that about 30 percent of the errors occur due to inadequate training of cosmonauts before performing some flight operation. There is a relationship between frequency of repeating the same operations and appearance of errors. The longer the interval between training and performance of an operation, or between repetition of operations, the more frequently errors are encountered. Of course, there are many other factors involved. Such as, for example, the place of a given operation in relation to others, its complexity, organization of work in the craft, adequacy of ground-based training devices, etc. Nevertheless, the influence of intermissions on regression of skills during long-term missions becomes one of the most important factors.

Onboard assessment of crews' ability to perform operations for a manually controlled descent following a long-term flight revealed that some cosmonauts who performed on a high level during ground-based training committed unforgivable errors. They confused the direction in which a control had to be moved and precision of control was diminished. During an actual fight such mistakes could lead to inadmissibly high G-forces and flaws in precision of landing.

The crew tries to overcome the problem of forgetting some cyclograms and algorithms of performance by

using the method of working according to onboard instructions, when literally each command, action and signal of the transport is checked against written instructions. This requires an enormous volume of reference documentation to be used. On the other hand, use of such "cheat sheets" is not always convenient or feasible. For example, urgent emergency actions must be performed with the needed algorithms in memory. It is also impossible to follow directions to remain ready for action that requires fine coordination, a sense of time and scope of control, visual estimates, etc. Not infrequently, there are also mistakes when using documentation after a long intermission, since mechanical performance of the algorithm described in them, without consideration of the prelude with respect to operations and conditions on board, does not guarantee the absence of undesirable mutual influences of onboard system. As an example, we can recall the incident where the engine cover was burned when the propulsion control system was tested during one of the missions aboard the Salyut-6 station. Cosmonauts make many mistakes in the cyclograms for using research equipment that is seldom used on board.

There is also positive training experience that was gained during the long-term missions aboard Soviet Salyut-6, -7 and Mir orbital stations. There, more than 30 special training sessions were held on different inflight operations and irregular situations.

A distinction can be made between several types of training that were used more often than others and some of which have already become a tradition and proven to be essential. We refer, first of all, to training that restores skills and abilities for emergency abandonment of the station in case of depressurization of compartments or fire. Such training is practiced periodically. Before the conclusion of long-term missions, cosmonauts recover their skills in important elements and modes of descent from orbit aboard a transport craft. During the missions, there was also training in complicated scientific experiments, in which unique apparatus has to be used, and for which appropriate simulators were not available during the period of ground-based training. More than once, the crews had to develop cyclograms of different technological operations for repair and assembly of equipment using special tools. The negative and positive experience gained indicates that it is mandatory to retain and maintain on an appropriate level cosmonaut training during long-term missions. And this requires development of a new direction in their professional training. What are the problems involved here, and how can they be solved today and in the future?

One of the problems is to deepen the very concepts of training, define the causes and patterns of its decline, elaboration of methods for assessing and predicting changes in it during spaceflights. Another problem is to develop technical means of evaluating achieved training and onboard training itself. It is impossible to solve the former problem without psychological and psychophysiological investigations. The latter depends on technical limitations and extent of development of simulator building.

Onboard Simulators

Since we are dealing with inclusion in flight programs of special exercises and training that would maintain or restore professionally important traits during part of the time that is scheduled for productive activity of cosmonauts, some justifiable objections arise as to the expedience of active development of such a direction. Assessments of inflight cosmonaut schedules indicate that more than 80 percent of the time is spent on various measures that provide only for maintaining vital functions and work capacity of the crew. A much smaller part of the time is used in the interests of technical and scientific investigations. This is indicative of low efficiency in using man in the spacecraft. However, addition of training sessions would have an even stronger effect on such an adverse ratio. Would it not be wiser to improve ground-based training of cosmonauts, before a mission, and to obtain results that would assure preservation of the needed knowledge and skills for a long enough time?

In the opinion of some specialists, in designing manned space vehicles one should strive for complete automation of all operations and providing the required reliability using hardware. In this case, the extent crew training is irrelevant. And it will become much easier to train them for flights. Only basic high professional of training of cosmonauts in some branch of science or engineering would then be important.

However, the proponents of such views overlook the following: efforts that have already been made to do without human participation in new and complex automated systems resulted in development of systems that were not adapted to operating with man and, moreover, they did not have the required flexibility with respect to changing working conditions that could be caused by man. For this reason, man was still involved in monitoring system operation, but because of the original designing trend his work was no longer adequately backed up with the necessary information. Probably such an approach will become more realistic as time passes, with improvement of automation equipment. But even then, we should expect that man will be involved in the work, although on a higher level; we refer to planning the programs, choosing alternative variants for implementing them, i.e., on the level of today's flight directors at the mission control center. Of course, such an increase in crew responsibility would not only fail to eliminate the question of training level, but pose it from a different perspective and with greater urgency.

Duration of a flight that leads to regression of skills is not the only reason for including onboard training procedures in a mission program. There are others: incomplete simulation on the ground of conditions in space,

A. Laveykin readying his spacesuit for extravehicular activity

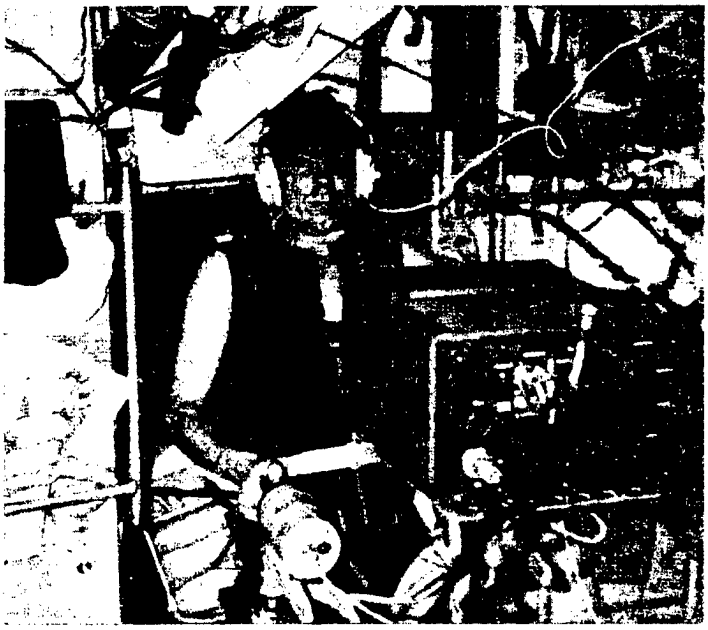
periodic need for unscheduled repairs, etc. For this reason, it is more expedient to consider improving crew efficiency by different means. First of all, they should be relieved of routine work referable to monitoring many systems, and the craft should be equipped with systems of independent planning and monitoring of daily programs of crew work. In addition, the means of exchanging information with the ground should be improved, the work stations and areas for rest should be more comfortable.

At the same time, adequately developed training devices for the most essential operations would permit using it spending less of the inflight work time.

Installation aboard space vehicles of special training equipment will increase the payloads put into orbit and take up some living or work space to the detriment of other interests. All this involves additional expenses for development, manufacture and operation of space equipment. It is no secret that it is by far not always that it is possible to solve the problem of successfully matching the dimension and weight of vehicles put in orbit to the capabilities of carriers, even for T/O [regular] onboard systems. How is this problem to be solved?

A partial solution would be to deliver training devices on board gradually, in modules, when the initial weight of, for example, an orbital station, is limited. Another solution is based on doing without self-contained onboard training devices and to use dual-purpose or built-in simulators that would provide for optimum use of weight and dimensions of onboard systems. With this approach, some of the onboard systems would have training modes of operation with use of mathematical modules of processes and display of modeled processes on the crew's information systems. While it is not possible at the present time to use this approach to find technical solutions that would meet the increased requirements as to reliability, speed of action and memory of onboard simulation computers, we can discuss some compromise variants of distributing elements of training devices on the ground and on board.

It is possible to use ground-based modeling devices based on experimental stands or trainers and a self-contained onboard training panel. In this case, exchange of information takes place via television and telemetry channels. But restrictions are imposed on such a solution as to duration of signals between the craft and earth, zones of communication and quality of data transmission. In each specific instance, choice of a variant of a training device to be used on board should be made with due consideration of actual technical feasibility at a given stage of development of cosmonautics.



Cosmonaut-researcher A. Levchenko during Pilot experiment, one of the purposes of which is to develop devices for onboard training in control of spacecraft movement

Psychological Aspects

The complexity of developing onboard training devices is not the only problem. Its other aspects are in the area of psychology and pedagogics. After all, there must be proper determination of the purposes of onboard training, how complete modeling must be of cosmonaut activities with onboard devices, and the procedures for rating the training level must be thought out. Even on the ground, where there are no weight or dimension limitations, such problems are not solved in the best way. Quite often, the skill and experience of the instructor save the day; he works with the crew constantly, is very sensitive to their current status, level of training of different cosmonauts, their coordination when working together, success and difficulties in learning some element of work. By appropriately correcting the predetermined training plan as related to the distinctions of a specific crew, a good instructor performs in essence the creative process of molding professionals. Such work is close to an art and is difficult to formalize or automate. Transferring training to the craft decreases the role of the instructor and requires more perfect automated devices to assess crew training and develop recommendations for the trainee. This, in turn, requires development of theoretical conceptions of processes of formation and extinction of various professionally important traits, mental processes of controlling man's performance in automated control systems as well. What approaches could be used to these problems?

Research in engineering psychology of recent years revealed that the human operator of any automated system can perceive the object of control and perform actions differently, depending on the extent of his training, variant of training, forms of delivery of information. The pattern of the object to be controlled, its possible states, variants and means of altering these states constitutes the most important element of controlling operator actions. It primarily determines the success of human actions. Apparently, as time passes, in the absence of practice, the images begin to recede and they do so unevenly. This is manifested by faster forgetting of some skills than others. In analyzing the extent of training of a cosmonaut, it is important to know how to assess the degree of formation of different elements of a pattern that are needed in some situation or other, to find the weak links in the chain of mental control. Then one can use methods of selectively targeting the elements of the integral image that are not reliable enough, and this would improve dramatically the effectiveness of instruction.

Of course, it is difficult to observe and study complex and strictly intimate mechanisms of mental images. Each specific instance requires it own methods and procedures of investigation. The enormous amount of exogenous and endogenous factors in relation to man must be taken into consideration. Without being able to discuss most of them, let us mention so-called subjective probability of occurrence of some irregular or emergency situation on board. Interestingly, there are great differences in subjective assessments by cosmonauts of probability of some malfunction of onboard systems during their training and actual work. In a real flight, they are much lower than in training, when the crew members know that the hair-splitting instructor constantly tries to detect some weak point in their actions and will try to "punish" them for it by introducing a situation where this flaw will become very acute and apparent to them.

During training and particularly exams, the crew is constantly on the alert for signs of malfunction and is mobilized to take immediate action to eliminate it. In flight, however, cosmonauts tend to trust the equipment much more than warranted by the real statistics on malfunctions and, being rather diverse, it cannot be compared to the training. This means that evaluation of the preparedness of crews for emergency action in training situations is somewhat exaggerated. It would be more realistic to give ratings when the crew is given tactical problems during real work without beforehand knowledge about them. Understandably, aside from technical limitations, there are also psychological and moral ones.

Even from this brief mention of problems of assessing and forming trained cosmonauts during long-term missions the following is apparent: to solve them there must be some special studies of cosmonaut performance, processes of formation of image of the mission, as well a adaptation of this image to the diversity if inflight situations.

The difficulties facing the new direction of professional training of cosmonauts will be overcome, not right away, but gradually. We believe that such training should not only reflect changes taking place in space technology, but anticipating its development it should affect the design of new manned space systems. An increase in inflight professional training is inevitable, and this circumstance must be borne in mind when designing a new generation of orbital stations, interplanetary craft and lunar settlements. However, the question of training equipment and methods requires separate discussion. But we should like to state here that inflight professional training of cosmonauts is presently at its nascent stage, and it has a great future.

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Goals and Tasks of the Medilab Space Medical Laboratory Project

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[Article by A. I. Grigoryev, Ye. A. Ilyin, S. F. Kholin, Yu. R. Ivanovskiy, N. V. Pravetskiy, V. I. Gushchin and V. V. Shakin, under the rubric "Experimental and General Theoretical Research," "Goals and Tasks of the Medilab Space Medical Laboratory Project"]

[Text]Proof that manned long-term spaceflights (SF) are possible, with retention of a rather high level of physical and mental work capacity, is the principal finding of biomedical research in space carried out thus far. Screening of cosmonauts in excellent health and with psychological stability was the basis for these achievements. However, further exploration of space, establishment of permanent orbital stations, the prospects for long-term missions, including a flight to Mars and related complication of research programs, the higher requirements as to professional training of cosmonauts, their work capacity, physical condition and, at the same time, expansion of the composition of crews due to inclusion of highly qualified specialists with a narrower range of adaptability advance to the fore the task of improving the existing system of medical support.

To accomplish this it is deemed mandatory to move on to a qualitatively new level of biomedical research in space by means of carrying out a broad front of comprehensive investigations. The main directions of future scientific developments are: medical support of SF, including preventive measures and psychological support, in-depth medical monitoring, medical aid as indicated; monitoring and control of habitat parameters in order to provide optimum living conditions for the crew; investigation of systemic reactions of man and mechanisms of their regulation during adaptation to SF factors; investigation of growth, development and evolution of biological systems during SF.

It is deemed necessary and timely to establish a specialized biomedical laboratory as part of the Mir orbital complex, outfitted with a set of latest research apparatus and computer hardware serviced by highly qualified specialists in space biology and medicine.

Implementation of this project offers the following advantages in the future program of biomedical research in space: a) expansion of equipment and methods base; b) improvement of quality and expansion of scope of research due to presence of physician and physiologist aboard the medical laboratory; c) system and predetermined frequency of dynamic studies; d) data processing onboard on a real time scale for ongoing correction of research programs; e) formation of data bank that permits forecasting the needs of the current mission, as well as to plan future missions and their medical support.

Planning of biomedical programs and choice of priority directions will be done as the logical continuation and deepening of preceding investigations, with due consideration of experience gained by clinical medicine, normal physiology and biological sciences.

The proposed set of medical, physiological, psychophysiological, biochemical and biological investigations aboard the biomedical laboratory will permit elaboration, choice and use of scientifically validated approaches, methods and means for the following:

diagnosis and treatment of diseases developing during SF;

monitoring and control of habitat;
prevention and correction of effects of SF factors;

control of vital processes during SF;

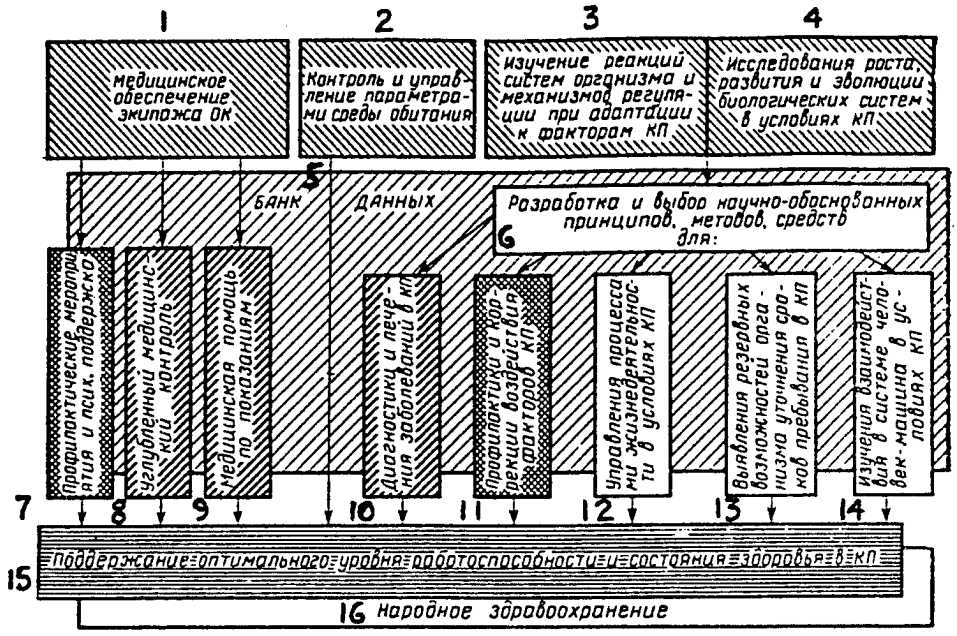


Figure 1. Hierarchic chart of goals and tasks of Medilab project

Key: 1—medical support of orbital complex crew 2—monitoring and control of habitat parameters 3—investigation of systemic reactions and mechanisms of regulation during adaptation to SF factors 4—investigation of growth, development and evolution of biological systems under SF conditions 5—data bank 6—elaboration and choice of scientifically validated guidelines, methods, means for: 7—preventive measures and psychological support 8—in-depth medical monitoring 9—medical care as indicated 10—diagnosis and treatment of diseases during SF 11—prevention and correction of effects of SF factors 12—control of vital processes under SF conditions 13—detection of reserve capacities of the body, determination of term of SF 14—investigation of interaction in man-machine system under SF conditions 15—maintaining optimum level of work capacity and physical condition during SF 16—public health care

detection of reserve capacity of the body, determination of optimum duration of manned SF;

investigations of distinctions of interaction in the man-machine system as applied to SF conditions.

Figure 1 illustrates the hierarchic chart of goals and tasks of the Medilab project.

Successful execution of given tasks would make it possible to improve on a basically new basis the existing system of maintaining an optimum level of work capacity and physical condition of man during SF. Moreover, analysis of the current status and prospects of development of space biology and medicine indicates that national and international organizations that are in the lead in space exploration are already planning to develop specialized biomedical laboratories as part of orbital stations. Establishment of an orbital specialized biomedical laboratory will be instrumental in further progress of manned cosmonautics, as well as public health care.

Assignment. The Medilab orbital specialized laboratory must implement the following:

in-depth medical monitoring of the crew of the orbital complex (OC), including periods of extravehicular activity, preventive and medical diagnostic measures, including urgent medical care as indicated, psychoprophylaxis and psychological support;

monitoring and control (additive and ongoing) of habitat, measures to improve sanitary and hygienic conditions aboard the Mir orbital station;

deployment of a set of latest preventive, medical diagnostic and research apparatus;

systematic biomedical research;

simultaneous execution of several special-purpose programs (Figure 2);

optimization of data gathering and analysis aboard the laboratory by means of a system for processing biomedical information;

ongoing communication and exchange of information with the ground medical control complex;

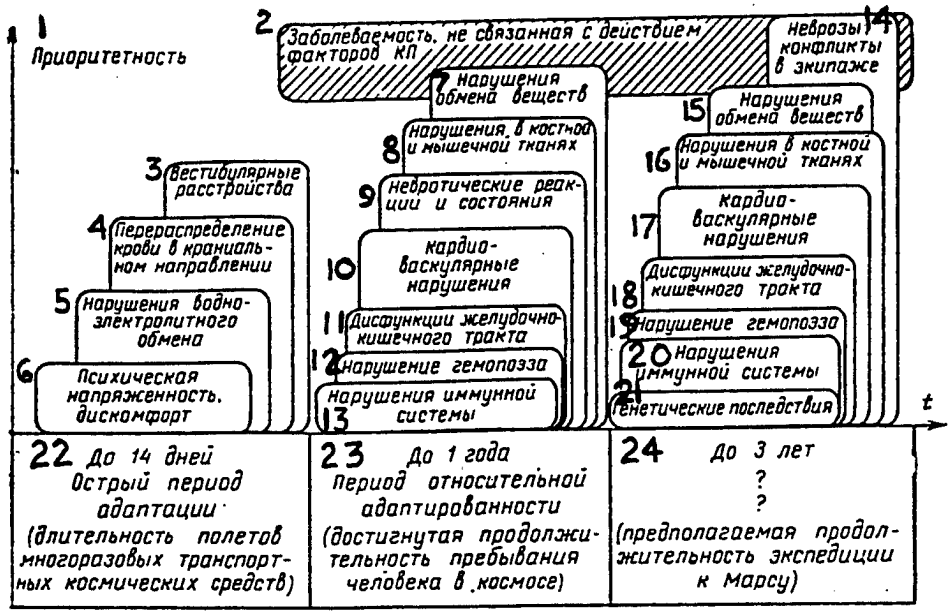


Figure 2. Possible functional disturbances as related to duration of spaceflight

Key: 1—priority 2—morbidity unrelated to effects of SF factors 3—vestibular disorders 4—redistribution of blood in cranial direction 5—impairment of fluid-electrolyte metabolism 6—mental tension, discomfort 7—metabolic disturbances 8—disturbances in bone and muscle tissues 9—neurotic reactions and states 10—cardiovascular disturbances 11-gastrointestinal tract dysfunctions 12—impaired hemopoiesis 13—immune system disturbances 14—neurosis, conflicts among crew members 15—metabolic disturbances 16—disturbances in bone and muscle tissues 17—cardiovascular disturbances 18—gastrointestinal tract dysfunctions 19—impaired hemopoiesis 20—immune system disturbances 21—genetic sequelae 22—up to 14 days: acute period of adaptation (duration of missions aboard reusable space transport) 23—up to 1 year: period of relative adaptation (time already spent in space by man) 24—up to 3 years: ? ? (projected duration of mission to Mars)

continuous work of two highly qualified and specially trained physicians.

The design of internal lay-out of the orbital laboratory, purpose, composition and outfitting of bays with research apparatus must provide optimum working conditions for specialists and efficient execution of research programs with consideration of modern advances and ergonomic requirements.

The construction of Medilab should provide protection against external space factors within the range of permissible standards set for manned vehicles.

The proposed large volume of scientific and practical measures aboard Medilab makes it necessary for a clinician and physiologist to be onboard. Before they start working aboard Medilab, physicians must undergo adaptation to weightlessness in the base unit of the station (for at least 7 days) and perform physicals on the crew in this time. Medilab operators will be replaced no more than once every 3 months (after fulfillment of a 3-month program cycle). The relieved shift will return to earth no sooner than 7 days after arrival of replacements. This period is needed for comprehensive examination of newly arrived cosmonauts in the period of acute adaptation to weightlessness, as well as to brief physicians about ongoing experiments and basic results of the work accomplished.

Medilab operators will take breaks and meals in the Mir station.

The construction of Medilab includes individual life-support systems, with a system of delivery of gas mixture and system of temperature control.

Design. The design of Medilab must provide for separation of the interior into four compartments (Figure 3): 1) transfer compartment (PO); 2) research compartment (NIO); 3) medical prophylactic compartment (LPO); 4) biological research compartment (OBI).

Transfer compartment. The transfer compartment is adjacent to the docking module of Medilab and is used to move from the Mir station to the NIO. Most of the work systems, recesses and cabinets for storage of spare supplies and instruments are in the PO.

Research compartment. The NIO is intended for in-depth medical monitoring of physical condition of the orbital complex crew, as well as investigations to study

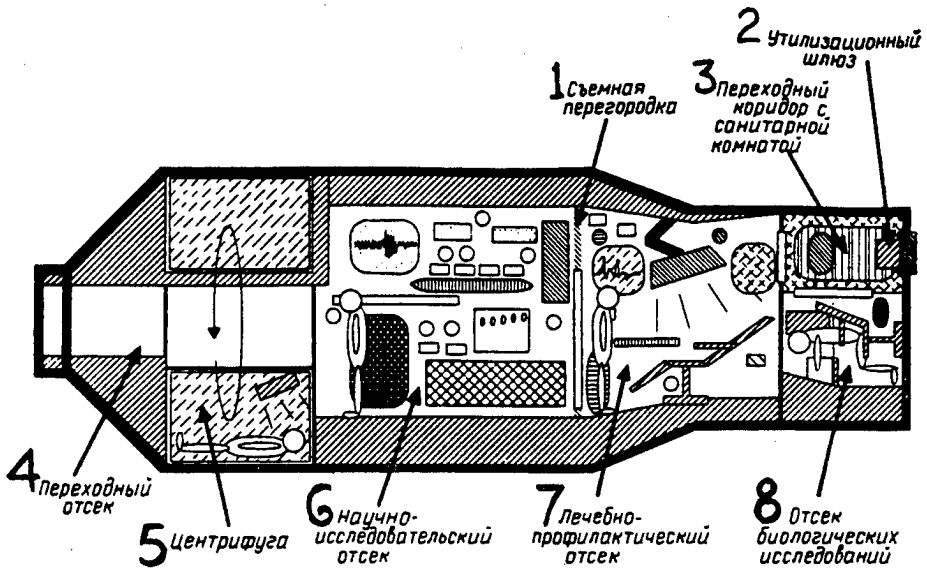


Figure 3. Variant of Medilab arrangement

Key: 1—removable partition 2—waste disposal airlock 3—transfer passage with sanitary bay 4—transfer compartment 5—centrifuge 6—research compartment 7—medical treatment compartment 8—biological research compartment

the condition of mechanisms of regulation of human physiological systems in order to develop and refine the ways and means of medical support of SF, as well as to assure optimum work capacity of cosmonauts.

The NIO must be situated in the central part of the orbital laboratory, between the PO and LPO.

Most of the research apparatus, system for processing biomedical data, as well as the system to produce artificial gravity (centrifuge) are located in the NIO.

The design of the NIO must provide for free access of physicians to research apparatus and experimental stands during investigations.

The research apparatus, as well as means of processing biomedical data must be located along the periphery of the compartment in recesses for apparatus stands using a unified system of mechanical, power and information commutation providing utmost compactness of arrangement and convenience in apparatus maintenance.

The different units, devices and instruments are arranged in the following apparatus stands for convenience of maintenance when executing the research program:

for examination of the cardiovascular system, including units for recording vascular pressure, parameters of central and regional hemodynamics by ultrasonic, electrophysiological, radioisotope methods, etc.;

for examination of external respiratory function, gas and energy metabolism, including mass spectrometers, units for measurement of pressure, volumes and flow of gases, tanks with gas mixtures, device to measure blood acid-base equilibrium, etc.;

for examination of the central nervous system and analyzer systems by electrophysiological methods, including amplifiers of biological potentials and electrostimulators.

The equipment used to prevent effects of weightlessness and for physical conditioning is situated in the NIO. It includes easily assembled portable cycle ergometers, a treadmill, system for positive pressure respiration, neurophysiological chair, etc.

The first work station of the physician for monitoring progress of investigations pursued in the NIO or LPO, as well as ongoing and retrospective analysis of data in dialogue mode of operation with onboard computers and formation of flow of information between Medilab and ground-based medical control, is located in the NIO. This work station is equipped with a sliding operator chair, display and keyboard, graphic printer, operator console with three-coordinate control, videotape recorder with recording videocamera, hardware for removal and input of data on magnetic media.

Medical prophylactic compartment. The LPO is designed for diagnostic work, preventive measures and giving medical care. In addition, biochemical and psychophysiological tests, as well as psychoprophylactic measures

aimed at maintaining a high level of cosmonaut work capacity, are performed there.

The LPO is located between the NIO and OBI, it is separated from the NIO by removable partitions and from the OBI by bulkheads.

The LPO must consist of three functional zones.

Zone A is for determination of physical condition and giving first aid as indicated. It should contain a portable folding chair-table for patients, anesthesia and resuscitation apparatus. The necessary instruments and diagnostic kits should be stored in special recessed cabinets according to function. A shadowless lamp must be secured above the chair-table to illuminate the surgical field (at least 500 lux). A portable x-ray unit, physiotherapy apparatus and bactericidal lamp are also located in zone A.

Zone B is for procedures related to taking blood samples and making biochemical tests. It should contain a removable box for taking blood samples and a stand with units of biochemical analyzers, pH-meter, spectrophotometer microscope, refrigerator, incubators, centrifuge, containers to store reagents, etc.

Zone C is for psychophysiological tests and psychoprophylactic measures. It should include the second work station for the physician or operator, analogous to the physician's work station in the NIO. It is additionally equipped with a unit for electroacupuncture diagnostics and treatment, apparatus for sessions of biological feedback, generators of odors and aeroions, ozonator, slide projector and removable wall screens for panoramic viewing of color images on the compartment walls in order to optimize the habitat, as well as a photophonostimulator. The second physician's work station should provide for verbal communication between the cosmonaut and the ground via a closed duplex channel.

The removal partitions make it possible to join the NIO with the LPO if necessary.

Biological research compartment. This compartment is intended for basic research to study growth, development and evolution of living systems under SF conditions, determination of general biological and genetic sequelae of long-term exposure of biological systems to weightlessness.

The OBI must be located in the distal part of the orbital laboratory, and communicate with the NIO and LPO via a lateral gangway.

The following is located in the OBI:

set of sealed-vial ["ampulized"] equipment for upkeep of 50 rats, which provides for automatic delivery of feed, removal of waste, temperature and lighting control, telemetric recording of parameters of motor activity, body temperature, heart rate, blood pressure of the animals;

biological stand with containers for incubation to make studies of cultures of plant and animal cells, plants and insects. The biological stand must include a freezer, unit for taking and fixing biological material (glove unit), and centrifuge;

work station for the research physician equipped with microscope with video attachment, device for sacrificing animals and performing surgical manipulations;

biochemical analyzer;

special recesses for storage of ancillary equipment and chemical reagents.

The design of devices for upkeep and manipulations with biological systems and material must provide for utmost use of sealed vials in order to prevent interaction of contents with the OBI environment.

Special filters must be installed at the intake and output of the air-circulating system in the OBI to provide additional removal of trace impurities from the air, as well as bacterial filters and odor-absorbing filters.

The lateral gangway that connects the OBI with the LPO and NIO should control pressure gradients so that air moves in the direction of the OBI when doors are open while the research physician goes into the OBI. There must be a special chamber (lock) in this gangway for recycling processed biological material, disposable sensors, personal hygiene items, etc., as well as a bay for sanitary and hygienic measures while working in the Medilab.

All of the compartments of Medilab must be equipped with systems of videotelephone and selector communications with the orbital station and the ground.

Project software. For the first time in space biology and medicine practice, a qualitatively new unified, standard quantitative procedure will be developed and successively used at all stages of the program for special-purpose integrated accumulation and generalization of data and findings by means of information science and computer engineering within the framework of the Medilab project. This procedure implies the use of modern information technology—integrated use of "knowledge base engineering" resources, systems analysis and mathematical modeling.

Already at the *preparatory ground-based stage* of the Medilab project, work has begun on generalization and systematization of previously gathered data from prior biomedical research programs, accumulation and systematization in a unified, efficient and quantitative form of scientific conclusions, hypotheses, mathematical models, biomedical theories, which are matched with prior findings, as well as ensuing scientifically validated practical recommendations and decisions, including plans for the Medilab program itself. Systems analysis of available data and goals of the program permits planning

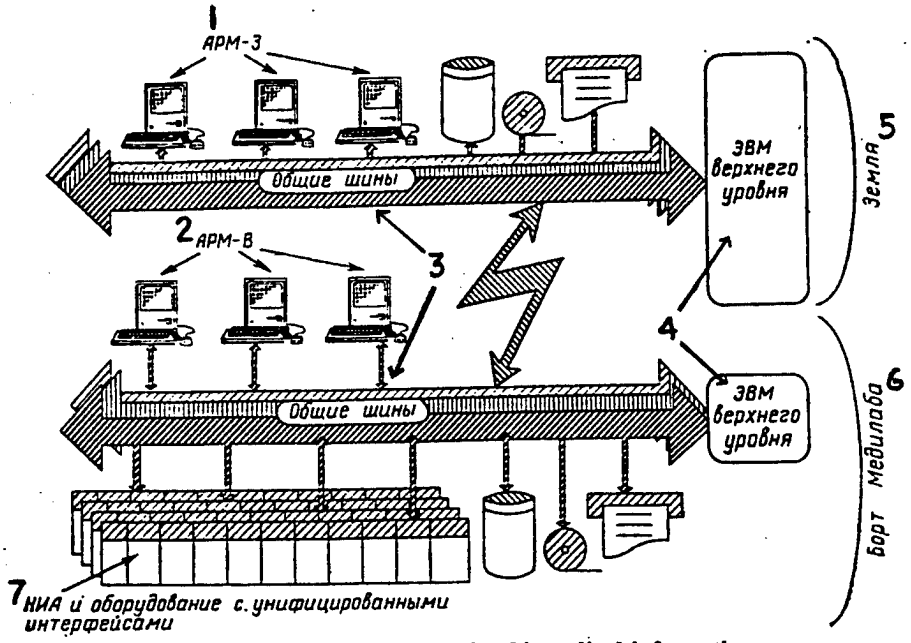


Figure 4. System for processing biomedical information

Key: 1—ARM-Z [automated work station on the ground] 2—ARM-B [automated work station aboard Medilab] 3—common buses 4—high-level computer 5—ground 6—onboard Medilab 7—research apparatus and equipment with unified interfaces

and validation of the purposes of subsequent investigations, determination of needed resources, including specifications for scientific apparatus, extent of its automation and system of processing biomedical data, mathematical, program and information support of Medilab. Additional mathematical processing and systematization of available data and knowledge is a distinctive type of mathematical modeling of future research programs on the ground. This processing, supplemented by expert evaluations by specialists, will make it possible to define the planned subprograms, biomedical investigations, with consideration of methodological advantages and flaws of prior programs, to relate these studies to one another in the form of cyclograms of experiments, and to optimize these cyclograms in order to obtain maximum information at minimum expense.

Thus, systematic use of information science resources and computers already at the preparatory stage provides the conditions for the natural and logical move to the *second stage*—experiments aboard Medilab, with their processing using analogous resources of the same information technology (Figure 4) which provides, at this stage, not only and not so much automation of routine operations dealing with execution of preplanned research, but the means for systematization of findings, systematic cyclic increments, increase in biomedical knowledge in the basis of findings from observing the outcome of a particular control or factor, both regular, monitored and irregular, unmonitored. Research physicians aboard Medilab and on the ground gain convenient and rapid access to the data base that is corrected with the most active participation of the research physicians themselves, being supplemented with new generalized data in the form of hypotheses, models and theories, which offer grounds for reflection, to continue the regular experiments and set up new investigations, to derive practical conclusions and recommendations in accordance with the questions, tasks and goals of the Medilab project.

This process is repeated in cycles until it leads to the set goal of the project, which is modified in accordance with changing conditions and completed studies. This event heralds the *beginning of the third stage* of the Medilab program, the turn to practical use of knowledge gained during the Medilab flight and on the ground.

Air-Launched Small Spaceplane Proposed

907Q0025A Moscow IZVESTIYA in Russian
24 Nov 89 1st Ed p 3

[Article by B. Konovalov, IZVESTIYA science columnist (Malaga-Moscow): "Into Space on Wings: Project for Launches to Orbit from 'Mriya' Airplanes"]

[Text] We have already become accustomed to the shape of a rocket that takes off vertically into space. But, on the contrary, we have not yet gotten used to wings on the spacecraft "Space Shuttle" and "Buran." The rocket "Energiya," which carries "Buran," automatically seems to be some sort of a "centaur." But it looks as if the symbiosis of aviation and rocket technology will be intensified. It is possible that the classical vertical launches into space will be replaced by horizontal takeoffs, like that of aircraft.

Two years ago at the 38th Congress of the International Astronautical Federation (IAF), which was held in Great Britain, only one project of the future—the English "Hotol" [horizontal takeoff and landing]—envisioned a horizontal winged takeoff. It did not receive the support of either the European space agency, or the British government. Financial preference was given to the "Hermes" space shuttle, which is launched vertically with the help of the "Ariane-5" rocket. But the "Rolls Royce" firm has still not abandoned the "Hotol" project.

At the 40th Anniversary Congress of the IAF, which was held this year in Spain under the motto "The Next 40 Years in Space," the idea of a horizontal takeoff into space not only was not put to rest, but, to the contrary, it received a strong boost. FRG specialists came out with the project "Sanger," which envisions a winged takeoff. The intentions of the designers are very serious—a consortium of firms for the implementation of the project has been formed in the FRG.

A real sensation at the congress was the project proposed by the famous Soviet designer G. Lozino-Lozinskiy—manager of the work on developing the "Buran" airframe. He proposed a reusable winged rocket system, whose first stage will be the powerful Soviet aircraft "Mriya," which has already successfully transported "Buran." In the proposed project, a small spaceplane with an external tank is to be mounted in place of "Buran." Such a system would make it possible to put into a fixed orbit—at an altitude of 200 kilometers—a load of up to seven tons in a manned version and eight tons in an unmanned version. The only disposable element in this system would be the external tank. All of the remaining elements are multiple-use, with all of the advantages and operational features, and reliability, of aircraft takeoffs. An air launch, of course, would require specific additional work on the "Mriya" aircraft, but then there would be a fundamental capability to launch from any geographical point on Earth, and not from rigidly fixed land-based cosmodromes. As is known, the closer the launch is to the equator, the greater is the use that can be made of the acceleration resulting from the Earth's rotation, and, other things being equal, the greater the cargo that can be put into orbit.

"We conducted a statistical analysis of American sources on cargoes placed in orbit," Gleb Yevgenyevich Lozino-Lozinskiy said to me after the report to the congress in Spain. "It turns out that until today about 90 percent of the cargoes launched into space are three tons and less. Of course, there are also heavier cargoes . But, as a rule, these are rare. This means that the system we propose could serve as a mass means of delivering cargoes to orbit. Because of this the creation of a new space system is worthwhile. Because now, according to American data, the cost of putting one kilogram of payload into fixed orbit (200 km) varies from $3,000 to $7,000. The proposed air-launch system will make it possible to lower these costs by a factor of 5-10, and, besides, the system will be reusable! Comparative analysis shows that the system we propose is more economical than the English "Hotol" project and the West German "Sanger," but the main thing is that it can be implemented much quicker. The "Mriya" aircraft is already developed, and a lot of work has already been done on a spaceplane . The fact is that this type of vehicle was being developed back in the 1960's in the A. Mikoyan OKB [experimental design bureau]. It flew successfully. From the standpoint of aerodynamics, a spaceplane had been worked out. Our cosmonautics could have followed another, more economical path of development, if this project had been implemented in its time. But, alas, Marshal Grechko, who then held the post of minister of defense, categorically declared that "we will not engage in nonsense."

Lozino-Lozinskiy, despite his honorable age, is full of enthusiasm and, as the saying goes, he is obsessed by the new idea. It, unquestionably, is realistic and attractive, but it requires a critical approach. We remember very well that when the American "Space Shuttle" project was being readied, everyone talked then about the beginning of mass launches into space. Reusability was presented on this basis as an economic blessing. But in fact there are still no mass launches. From an economic standpoint, the "Space Shuttle" system was less advantageous than the traditional one-time-use rocket. Lozino-Lozinskiy refers to American data on the cost of launches into orbit. Unfortunately, we still do not have our official data on how much it costs to launch a one-kilogram payload into a fixed orbit by the Soviet series rockets "Tsiklon," "Cosmos," "Soyuz," and "Proton," but it is known that the launches are cheaper than those with American systems.

Therefore, I asked Gleb Yevgenyevich outright:

"Will it be cheaper to launch a one-kilogram payload with the proposed aircraft-rocket system in comparison with the classical 'R-7' rocket (developed under the management of S.P. Korolev), or, more accurately, its modern modifications—'Soyuz' and 'Molniya'."

"No," the designer answered honestly, and he explained immediately: "The new system, of course, would be

developed at current prices, but the 'R-7' was born in the 1950's, and it continues to be appraised according to a cost that was designated many years ago. For the producers, this, evidently, is unprofitable."

I had an opportunity at the congress to personally ask Yu. N. Koptev, chief of the directorate of space equipment of the USSR Ministry of General Machine Building, whether this was the case, and I requested that he assess the idea of the representatives of the USSR Ministry of the Aviation Industry in general.

"Yes, the price of the 'Soyuz' rocket is an old one," said Yuriy Nikolayevich Koptev. "But I want to say with all seriousness that there is no space equipment that would be unprofitable for the producing enterprise. No one gets very rich, but the rates of profit are no lower than in the production of any other machine building product. The cheapness of the 'Soyuz' rocket is tied to the fact that it has been perfected. The plant produced more than a thousand such rockets and, naturally, highly organized and economical production has been established there. As for an air launch into space as a whole, then it could only be welcomed if it were already implemented. A small spaceplane could replace the modern 'Soyuz' transport ships and perform other tasks. But to start its development today, there must be complete confidence that there will be a need for very intensive cargo traffic on the 'Earth-orbit-Earth' route. Thus far we do not have this confidence. Existing systems can easily handle the limited cargo traffic. Also, we should not overestimate the work that has already been done. The 'Mriya' also will require additional work, in order to become an airborne 'launch platform,' and additional work will be required on the spaceplane as well. Because the design essentially is new. Our specialists believe that there will be a need to enter a new stage in the creation of materials, load-bearing units, and control systems. Approximately the same kind of broad cooperation of the ministries will be required as was required in the development of the 'Buran.' Something or other might be used from the 'Buran,' but not everything by far. The development stage will be expensive. Of course, this will not be R14 billion, as in the 'Energiya-Buran' project, but, all the same, the expenditures will be considerable. Today, under the conditions of a huge shortage of resources in the country, it is hardly likely that the USSR Supreme Soviet will agree to allocate money to a new project."

"Yuriy Nikolayevich, of course, it is good that the 'R-7' rocket was so reliable and viable, but it is far from ideal—it requires a large number of people to assemble, tests at the cosmodrome, and preparations for launch. Will it be replaced?"

"It will be. The 'Energiya-Buran' project envisioned that the strap-on unit (there are four of them) of the first stage of the 'Energiya' rocket would serve as the basis for the creation of a new rocket. Such a two-stage rocket, 'Zenit,' is completing testing. Its first stage is practically the ready-made part of 'Energiya.' The 'Zenit' rocket can put a load of 12 tons into fixed orbit. It has been conceived at the contemporary level of design, production, and operation, and it will gradually replace the 'Soyuz' rocket."

Yes, the spaceplane project not only has analogous competitors, but also the traditional vertical takeoff rockets. Economy would vote for the new project, if there was a realistic need for mass launches. Under current conditions, this can only be in the event that a new aircraft-rocket system becomes an international means for orbiting payloads that all countries could use. G. Lozino-Lozinskiy believes that if we are to proceed from common sense and save resources for all countries who are going into space exploration, then the aircraft-rocket system absolutely must be made international. Because it can take off from an airfield in any country, and the advantages of cooperation are apparent.

Unfortunately, the traditional opposition in rocket technology of the socialist and capitalist countries still remains a reality. To this day, political aspects impede cooperation in cosmonautics. The United States forbids the launch of satellites of any country with our rockets if the satellites have any American components, and with the widespread cooperation in the West this is practically inevitable. The rapprochement of the sides is coming with great difficulty. It is enough to mention that the androgynous docking unit, which was developed for the "Soyuz-Apollo" project, has not been used even once since 1975. We will hope that the new thinking that has seized our planet will change the situation in cosmonautics as well.

In conclusion, it is necessary to pay attention to the fact that the aircraft-rocket system is much more time-efficient than the traditional ones. This is very important for ensuring the safety of cosmonauts. Now, if something happens in outer space, several weeks might be required to launch a new rocket with a spacecraft. This could be too late. In our day, satellites are used for speedy notification of ships at sea or aircraft in distress. For this, the international "Kospas-Sarsat" [Search and Rescue Satellite] system was created, owing to which thousands of people have already been saved. Thus, perhaps, an international service for the rescue of cosmonauts will also be established? The air-launched rocket system would be the best technological means for this noble aim.

An agreement was reached at the congress in Spain that next year specialists from the USSR, the United States, France, and the European Space Agency will meet in order to consider the problem of ensuring the safety of space flights. We will hope that this meeting will be fruitful and will lead to real results.

Leonov Interviewed on Prospects for Space Plane Technology

907Q0010 Moscow KRASNAYA ZVEZDA in Russian 16 Sep 89 p 4

[Interview with Maj. Gen. Avn. Aleksey Arkhipovich Leonov, Twice Hero of the Soviet Union, candidate of technical sciences and USSR Pilot-Cosmonaut, by KRASNAYA ZVEZDA correspondent Col. M. Rebrov, under the rubric "Dialogue With An Attempt at a Forecast": "Aviation of the 21st Century—The Aerospace Plane: Plans and Reality"; photo callout reads "Our interlocutor is Maj. Gen. Avn. A. Leonov, Twice Hero of the Soviet Union, candidate of technical sciences and USSR Pilot-Cosmonaut]

[Text] [Rebrov] Aleksey Arkhipovich, aviation and the space program are perceived by many people as two different fields of human endeavors that differ not only in hardware, but also in the purposes of the missions and the methods for supporting them. And that has its own kind of logic. However, today, now that the [American] Shuttle and Buran have demonstrated their worth, and many scientists and designers are working on the development of the Hermes, Sänger and Hotol projects, those two areas are tending to converge.

The growth of technological progress has led the scientists and designers to the idea of the "unification" of aviation and space equipment, a concept that involves a space future for aviation and the development of space planes. What are these aircraft? What are they needed for? What might they be like? Those are the first questions that come up on the road that stretches from the idea to practice.

[Leonov] I find a conversation on this topic interesting now if only because escape-velocity aviation is not just an abstract concept or some harebrained direction in the development of hardware. Preliminary studies pertaining to the possibilities for its development have been under way for years now in various countries. And projects that are quite workable exist. According to the concept of their developers, hypersonic airplanes will used to transport passengers from continent to continent in a matter of minutes, while the unique "hybrids" of an airplane and a rocket will be the equivalent of the boosters that carry people and cargoes into orbit...

[Rebrov] The TU-144 supersonic passenger plane had barely just flown when there were discussions about what kind of plane should replace it. There were quite a few arguments in favor of the fact that a new-generation high-speed airplane would be viable. This served as the stimulus for the development of the American X-30 project. But there were also other projects. You yourself have been involved in one of them.

[Leonov] I remember the period of time when our group of cosmonauts—which included Gagarin, Titov, Nikolayev, Popovich and others—were studying at the Zhukovskiy Academy. Back then, 15 diploma projects were done on an aerospace craft very similar to Buran. The idea for such diploma work had been approved by Sergey Pavlovich Korolev, and the work was done under the supervision of Professor Sergey Mikhaylovich Belotserkovskiy.

[Rebrov] I would add that aviation and rocket-and-space technology are now, as it were, moving toward one another. And this interaction at the juncture of two fields of science and technology has turned out to be extremely fruitful.

[Leonov] Yes, even now, during the research and development, interesting results have been obtained in the field of the development of power plants, construction materials, production technology, the selection of aerodynamic configurations and so on. At the same time, despite a number of common features, there are also substantial, major differences. Aviation's aircraft use the wing to create lift. The aerodynamic forces counterbalance the weight of the airplane and ensure its maneuverability. Spacecraft use a different principle: the weight of the vehicle flying around the earth is compensated for by centrifugal forces.

[Rebrov] A rather curious situation is taking shape. The space age has seen immense achievements in the speeds, altitudes, and distances of flight: from the environs of earth to the edge of the solar system. At the same time, the vast areas encompassing speeds of 5,000-28,000 kilometers per hour and altitudes of 35-150 kilometers remains almost unexploited.

[Leonov] For the time being, it is unaccessible for our ordinary airplanes. But it is precisely that region of the upper layers of the planet's atmosphere and so-called hypersonic flight speeds that separates aviation and the space program.

[Rebrov] Hence, Aleksey Arkhipovich, the logical striving to master this range of speeds and altitudes which separate aviation and the space program. The modern transport plane is capable of carrying nearly as many people as a passenger train can carry. The flying weight of aircraft such as the AN-225 Mriya is more than 500 tons. The launch weight of the Energiya booster is 2,500 tons.

[Leonov] The striving is indeed logical and even natural, although the task is extraordinarily complicated. There have been such discussions about this in the foreign press. Some maintain that all the talk about an space plane is just "hypersonic hyperbole," the technical difficulties are diminishing, the expenditures for development are underestimated, and the opportunities for use are being exaggerated. They feel that it will be the most complicated airplane whose development was ever undertaken. Others, conversely, have very optimistic frames of mind: the technology, they say, is clear, and it is simply waiting to be used in an innovative manner.

However, before giving an assessment of well-known projects like, say, the English Hotol, the Franco-European Hermes, or the West German Sanger, let me remind you that, in order to achieve so-called orbital velocity—8 kilometers per second, or 28,000 kilometers per hour—it is necessary to expend a large amount of energy. It is impossible to do that with a single-stage booster, no matter what kind of fuel is used, be it solid fuel or the most powerful fuel—liquid hydrogen and oxygen. That was proven long ago by K. E. Tsiolkovskiy.

[Rebrov] That's precisely the reason that reusable spacecraft like Buran or the Shuttle have such a complicated structure.

[Leonov] These complexes are multistage systems. Thus, the Energiya space-rocket transport system includes a main unit and strap-on units. The Shuttle, with its solid-fuel boosters and expendable fuel tank, can also be called a multistage system. A version of a single-stage space plane capable of horizontal take-off is being studied this very moment. Such a take-off requires large energy expenditures that are associated with the aircraft's lengthy stay in the lower, dense layers of the atmosphere. In addition to the need to build up speed to 28,000 kilometers per hour is the need to overcome aerodynamic drag.

The technical literature contains various versions of a proposed solution to this problem. One of them is to replace part of the oxygen carried aboard the rocket-powered aircraft with oxygen from the surrounding atmosphere. At altitudes of up to 30-40 kilometers, there is still plenty of it. Consequently, a ramjet engine could be used. That way, only propellant is carried on board.

[Rebrov] Research doen abroad has shown that ramjet engines are capable of operating at speeds of Mach 10-12, while the flight altitude with the use of such engines amounts to several dozen kilometers. But for the final stage of the flight, naturally, a rocket engine of the "classic" type is required.

[Leonov] I agree. The development of aerospace planes depends on the development of a combined jet engine capable of operating both in the atmosphere, using the oxygen from the air, and in outer space, as a "rocket." But, in addition to that, there are also other problems and difficulties which the specialists must overcome. For example, aerodynamic heating. However, the prospects opened up by such technology are attracting interest and steady attention to it. But then, the views on the goals of the program are varied.

[Rebrov] This is probably explained by the fact that the so-called hypersonic planes are regarded as aerospace planes.

[Leonov] Indeed, at times, opinions are expressed that speeds which exceed the speed of sound by 6-, 8- or 10-fold are quite adequate. I would like to clarify something right now. Such speeds are splendid for flights carrying business people and passengers in a hurry. But for cosmonauts, they are clearly inadequate. What's needed are boost engines that will make an airplane into a rocket. And the concept will prove its worth if such an aircraft and its structures are designed for repeated use: 100 flights or more.

Judging by the reports in the press, the future aerospace plane will be whatever the military—its true customer—wants to see. The Western military agencies do not conceal the fact that they are interested in an aircraft that can conduct reconnaissance and tracking and can be used as a bomber that does its job quickly and suddenly. They feel that it will be able to perform tasks which are difficult for ordinary space vehicles, since the trajectories of the latter are easy to calculate.

[Rebrov] Space planes can also play a different role. Many projects that cannot be carried out now because of the high cost of launching space rockets may turn out to be entirely practicable as a result of the possibility of reducing expenditures in the use of aerospace equipment. To a great extent, the restrictions that the current equipment for lifting payloads into space impose on space research will fall away.

[Leonov] Develop aircraft of this type for the purpose of the creating boosters whose cost and performance specifications will be comparable to today's jet airliners—and then flights to space stations will become just as commonplace as airplane flights between cities and continents of earth.

Our country is extremely vast, and the problem of inexpensive and rapid transportation of people and cargoes is very crucial to the harmonious growth of all its regions and to the establishment of mutually advantageous ties between the republics and krays. The problem can be solved by developing fundamentally new types of aircraft, in addition to ordinary aircraft.

[Rebrov] The sky of the 21st century... How many new aircraft will begin to make regular cargo and passenger trips...

[Leonov] And all that is entirely realistic and may find practical forms in the not-so-distant future. I would like to emphasize that this problem is innately fundamental, and its solution will not only entail the development of a reliable, multipurpose aerospace plane, but will also become the foundation for new concepts and achievements.

What is required is the extremely lively participation of science in many areas, the development of new materials and mathematical models, the use of powerful computers and new technologies... To go it alone is too costly. The price of individual efforts for the development of reliable and economically efficient aerospace planes is exorbitantly high. Widespread international collaboration and sensible cooperation are necessary. The International Association of Pilot-Cosmonauts is in favor of that.

'Zenit' Booster Rocket in Final Test Stage

LD2411224989 Moscow World Service in English 1600 GMT 24 Nov 89

[Text] In the Soviet Union trial tests are now in the final stage of a new powerful booster rocket, Zenit. This follows an announcement to the press by (Yuriy Koptev), an official for the Ministry of General Machine building producing space technology.

The new rocket, taking into orbit a payload of 12 tonnes is to replace the Soyuz booster, currently in use for launching all Soviet space crafts.

Living Conditions Aboard Orbital Space Stations

18660210 Moscow TEKHNIKA—MOLODEZHI in Russian No 7, Jul 89 pp 15-19

[Article by Pavel Popovich, USSR pilot-cosmonaut, twice Hero of the Soviet Union, and Aleksandr Zheludkov, leading designer, under the rubric "Problems and Searches": "In Orbit—With All the Conveniences"; first three paragraphs are source introduction]

[Text] *Our authors, Pavel Popovich and Aleksandr Zheludkov, have already told our readers about rocket-and-space systems without which the development of near-Earth space would be impossible (TEKHNIKA I MOLODEZHI No 10, 1987, and No 4, 1988).*

But it is one thing to open a road to the cosmos, and another to live and work there. The cabin of a transport spacecraft has a little more room than the passenger space of an automobile. To sit there, even if only for a week, without getting out is torment. At the very dawn of the space age, S. P. Korolev formulated the general direction for the development of Soviet manned space flight: create orbital complexes consisting of long-duration orbital space stations and transport ships to supply them and change crews.

An orbital space station is a home and workplace for the cosmonauts. In this article, you will learn what that space home is and how people live and work in it.

A Stroll Around the Space Home

For a cosmonaut living in an orbital space station, every feature of the layout and every cubic meter of living space in the space home means immeasurably more than it does to the most inveterate stay-at-home individual or homebody on Earth. A mission lasts many months. Like it or not, you live like a hermit behind four walls.

About the walls. In the work module of the station (where the crew works and rests), there are four walls, as in an ordinary room. Plus a floor and a ceiling. So that in weightlessness cosmonauts will not become disoriented, the surfaces are painted different colors: sandy-cream, apple green, grey, and brown (on the Mir Station).

The volume of living area is roughly the same for all Soviet orbital space stations—about 50 cubic meters. By Earth standards, that is a 20-square-meter room in a typical house. Of course, that is not very spacious for three people, not to mention 5-6. Again, that is by Earth standards. However, cosmonauts are not "tethered" to the floor surface and can therefore use their cubic meters much better than you, dear reader, can use yours square footage. And when the volume of the orbital space station is compared with the free interior volume of the Soyuz (6.5 cubic meters), the space house appears quite spacious.

The housing of the work module consists of two cylinders of differing diameter. Correspondingly, the "room" is divided into two parts: narrow and wide. The module's interior walls are made of flat decorative paneling. The furniture consists of chairs and small tables. And you could add to that, perhaps, the control consoles. Beneath the paneling is onboard equipment: control systems and life-support systems. The central control station is located near the bottom of the narrow section of the module, and next to it are the control panels for the science equipment. In the wide portion of the module are shelves for provisions, a refrigerator, physical-training equipment, a toilet, and, beginning with Salyut-6, a shower. On Mir, the designers even managed to find space for two "pencilbox" sleeping areas.

Spacecraft can dock with the station either at the forward end or the aft end. (On the first-generation space stations—Salyut through Salyut-5—only forward docking was possible.) Therefore, on two sides of the work module there are hermetically sealed, buffer compartments (forward transfer module and aft service module transfer tunnel), where the docking fixtures are located. After sealing the the "transfer space," you can pump the air out of it, and crew members can exit through the hatch into open space. Also, the buffer compartments protect the work module from damage (and, consequently, from a possible pressure loss) during docking.

The service module is aft, that is, in the wide portion of the station. (In first-generation space stations, it resembles a cylindrical bottle, the bottom of which is connected to the end of the work module.) That is where the vernier orbital and attitude-control thrusters are located, as well as the fuel for them. On space stations that have a second, aft docking port (in addition to the first, which is located forward), the service module had to be placed around it, in the shape of a ring whose diameter is equal to that of the wide portion of the work module.

How Many Doors Does a Home Need?

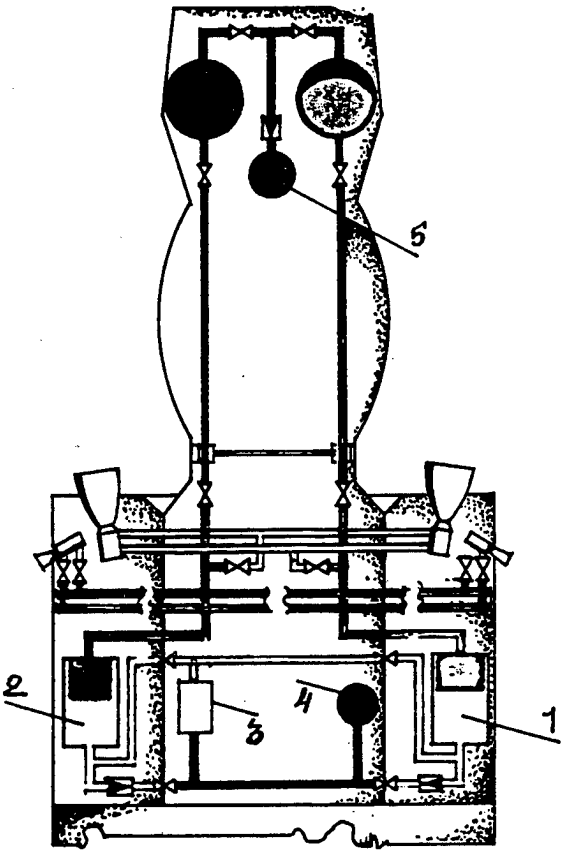
That is not an idle question at all, especially when it comes to a space home. After all, one can correctly determine what generation a space station belongs to by the number of transfer hatches (and docking ports) it has.

The most we managed to get out of first-generation orbital stations was two expeditions that lasted a total of about three months. And no wonder. After all, they had only one docking port. It was occupied by the craft that

had brought the crew up. There was no place to dock a cargo craft. Therefore, it was not possible to send up new supplies. As soon as the water, food and fuel were used up, we had to say goodbye to that Salyut, and it would be taken from orbit and would fall into the western part of the Pacific Ocean.

The installation of a second docking port gave longevity to the second-generation orbital stations (Salyut-6 and Salyut-7). Now the research that could be conducted in space was so long-term that the need arose for ever newer scientific instruments. But not all of them could be squeezed through the 80-centimeter hatch of the docking assembly. What were we going to do? Launch a new station for each new research program?

The problem was solved with a simpler solution. The third-generation orbital station (Mir) has not two, but six docking ports. In addition to the axial ports, there are four radial ports around the transfer module. With them, Mir can accommodate special laboratory-modules. (They will, of course, dock normally, like a spacecraft, to the forward docking port, and then later a manipulator arm will transfer them to a side port. A station's scientific potential no longer depends upon its size. The station is being transformed into a base unit surrounded by modules with scientific equipment. The first of them, the Kvant astrophysical module, is already docked to Mir.



Refueling of station's consolidated propulsion system is performed as follows: the tanks for the oxidizer (1) and the propellant (2) are emptied of their nitrogen by a compressor (3) tht pumps the contents into a high-pressure container (4). The empty tanks can now receive fuel from a cargo craft. A container full of compressed gas (5) alternately blocks the feed system for the oxidizer and fuel.

Power Sources

We have already mentioned that the life of an orbital station is largely determined by the amount of fuel on board. When the tanks are empty, the station doesn't just lose its capacity to move from one orbit to another and to change its attitude; in time, it will fall into the denser strata of the atmosphere and burn up, as happened to the American Skylab. The reason for that is simple. Near-earth space is not a vacuum. Even the few molecules of air located there are sufficient to gradually slow down a spacecraft.

Unsymmetrical dimethylhydrazine, a nitrogen-containing hydrocarbon, is the propellant for the engines of orbital stations (and spacecraft). It is a colorless, toxic liquid that smells like ammonia. It is only slightly volatile (consequently, there is no danger of explosion in tanks heated by the sun). But the main thing is that it ignites practically instantaneously upon contact with the oxidizer—nitrogen tetroxide. The engine's lack of inertia is a big advantage in space flight, where the smallest error in spacecraft control (for example, in docking) threatens the most severe consequences.

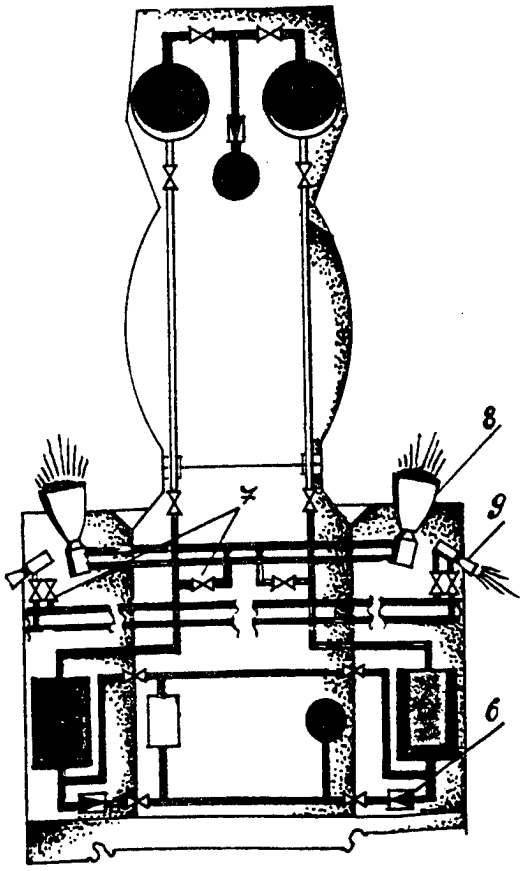
In addition to the orbital correction engines, space stations also have low-thrust engines for attitude control. In addition, gyroscopes are also used for attitude control. If the flywheel of the gyroscope rotates in one direction, then, in accordance with the law of the conservation of momentum, the entire station will start rotating in the opposite direction. The first flywheels were installed on the Salyut-3.

What does the power come from to rotate the flywheels? The flywheels are connected to an electric power supply system that is powered by solar batteries that automatically track the sun (a mechanism for turning the solar cells was also installed for the first time on the Salyut-3).

Living in Space Isn't Easy...

Here is how Valeriy Ryumin, a USSR pilot-cosmonaut, recalls his daily life on board an orbital space station:

"One can get used to anything! We rise at 8:00. The alarm is the kind with an irritating sound. We get right out of the sleeping bag and go to the food warmer. Then we do some exercise with the expanders, and by that time breakfast is ready. We shave every morning with an electric razor with a special attachment to collect the whiskers. We brush our teeth with an electric toothbrush.



The fuel system is prepared for operation. Compressed nitrogen, passing through a reducer at 20 atmospheres (6) forces fuel, when the valve (7) is open, into the combustion chambers of the fine-adjustment thrusters (8) and the attitude-control engines (9).

We wash our faces and hands with towels soaked in a special lotion. Generally, we perform all the orders of Moydodyr [not further identified], depending on the circumstances, of course.

"Breakfast took about 10-15 minutes. It consisted of various types of canned meat, cottage cheese in a tube, bread, tea or instant coffee, and a pastry. A little of everything. Not always tasty, perhaps, but nutritious.

"At 9:30 we started work. An hour later, physical exercises. On Earth, what a joy it is to limber up! But here it's a lot of sweat. Incidentally, the sweat gathers in drops, thousands of them all over the body. And those little pea-shaped droplets can only be removed with a towel.

"Dinner was soup from a tube, canned meat and its juices, and your choice of milk or tea. Sometimes there were onions or garlic. It always needed salt. There were many sweets, but they were not popular.

"Then there was more work—research and observations for 2-4 hours and sometimes, if it could not be interrupted, for even longer.

"Then it's physical exercise again. I have never had a desire here to do physical exercise. I had to force myself every time.

We worked on a ground schedule, in accordance with labor laws, with two days off. True, one of them was a cleaning day spent vacuuming or bathing. Oh, that bath in outer space! It took an entire day to get it ready, heat up water, and put everything away afterward. Have you ever seen how a dog gets out of the water and shakes itself off? That's how we were in that shower tube, shaking drops of water off ourselves just like a dog. But it was OK anyway!

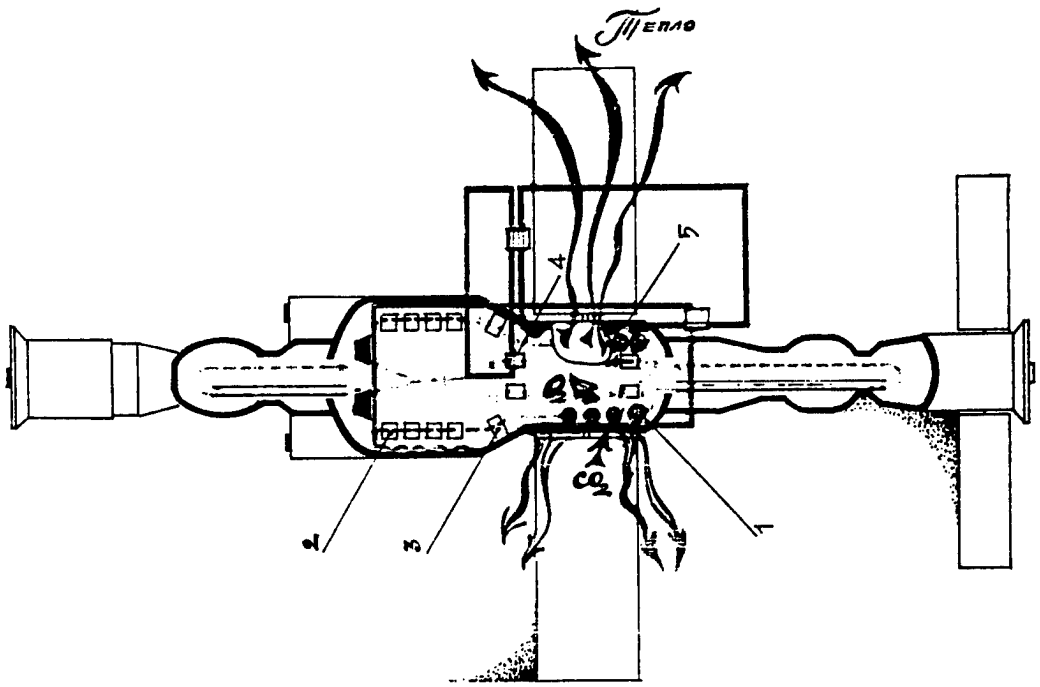
"Once during a communications session, television commentator Sasha Tikhomirov reproached us for our extreme neatness. Here we were, he says, preparing for the televised session, laying everything out and putting things away, when what he needed was a working environment. He ought to try being up here! Then he would understand that in space 'lyrical disorder' doesn't make it."

So, the crews of orbital space stations (as well as their developers—the scientists and designers) must solve many big and small problems. For a starter, the concepts of "lighter" and "heavier" lose their meaning, as does the convection of gases. The head of an immobile person soon becomes surrounded by a cloud of the very carbon dioxide he exhales. If he falls asleep, he may not wake up. That is why station fans run continuously, moving the air through the living area. The air is then cleaned in dust filters (dust is created even in a hermetically sealed enclosure—from clothing).

There are also harmful impurities in the station atmosphere. The human body releases about 400 of them, including carbon monoxide, ammonia, aldehydes, ketones and other poisonous chemical compounds. All of them are adsorbed by special filters.

But perhaps the main "harmful impurity" is carbon dioxide. The air in a station has to be constantly regenerated, the carbon dioxide removed from it and oxygen added. This is done by a regeneration unit containing potassium superoxide (K_2O_4). Gradually decomposed by water vapor in the air, it reacts with carbon dioxide, forming potassium carbonate and giving off oxygen.

How do you run water in a shower? That's also problem. More precisely, it is not technically difficult to run a shower, but how do you see to it that the water and the soap aren't sprayed all over the place? Warm air is passed through the shower unit, which is a unique aerodynamic tube. It draws off the excess moisture, which is then gathered in sealed collectors, and then the air, after being cleaned, again enters the module.



The air in an orbital space station is purified of carbon dioxide and is enriched with oxygen in regenerators (1). Fans push it through the living and working areas and then it makes its way behind the panels, cooling the equipment (2). A heat exchanger (3) collects excess heat and radiator panels radiate it into outer space. Moisture from the air condenses on the cooled surfaces of refrigeration-drying units (4) and supplements station's water supply.

When cosmonauts bathe, they must wear special goggles (so that soapy water will not get in their eyes; the high surface tension in weightlessness causes the water to try to flow all over the body). They use a breathing hose with a special mouthpiece to prevent inadvertently inhaling free-floating liquids.

Spacecraft sanitation equipment works by suction. Unfortunately, a system for extracting water from urine has still not been developed for orbital stations. That is one of the main reasons for water loss. Nevertheless, today about half of the water is recycled. It is "pulled" out of moist air.

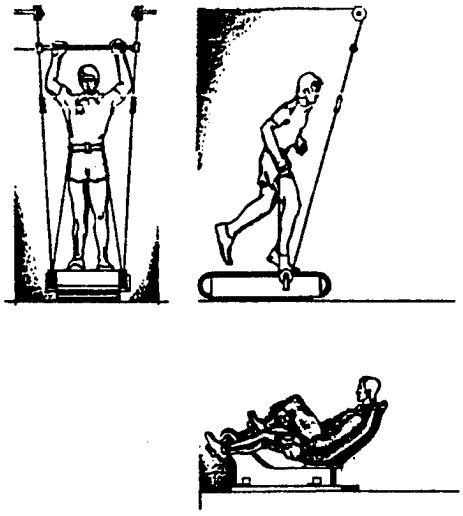
Relative humidity in orbital space stations ranges from 30 to 70 percent. Excess moisture forms small droplets of very fine dew on the cool surfaces of refrigeration and drying units. The capillary effect is used for its further condensation. Hygroscopic "blotters" draw the dew off into a moisture settling tank.

The temperature in the station is also constantly regulated. The normal temperature is 20°C. The multilayer insulation (made of metallized film) of the station's hull prevents it from dropping to absolute zero. People and operating electrical equipment give off heat. That is enough to compensate for the unavoidable heat losses. Moreover, when a lot of scientific instruments are turned on, temperatures in the work module may jump above allowable levels. How can this be handled? Remember that if you want to keep from getting too hot on a cold day after a brisk walk, all you have to do is take off your gloves; the excess heat will escape through your palms. Their thermal conductivity is regulated by the body. The station's "palms" are the outer skin of the narrow portion of the work module, where radiator panels are installed.

About eating. There can be no scraps on plates or little crumbs in outer space. Therefore, bread is not bitten off; rather, whole slices (appropriately sized, of course) are put into the mouth. The first meals, beverages, and juices were packed in 160-gram tubes and in 100-gram cans.

Altogether, there are more than 70 types of food on board. The food value of the cosmonaut's daily ration—3,200 calories—would suit, say, a lathe operator. What are those calories expended on, you may ask, if in weightlessness it is not necessary to exert the slightest effort to move abpit? It turns out that they are used to struggle against weightlessness.

The long-term absence of gravity has a pernicious effect upon the human body. The cardiovascular system and muscles weaken, and bone composition changed (calcium salts are "washed" out of them). There is one antidote for that—intensive physical exercise. Cosmonauts expend 2,500 calories daily doing physical exercise.



Athletic equipment used on orbital space stations: treadmill and bicycle ergometer.

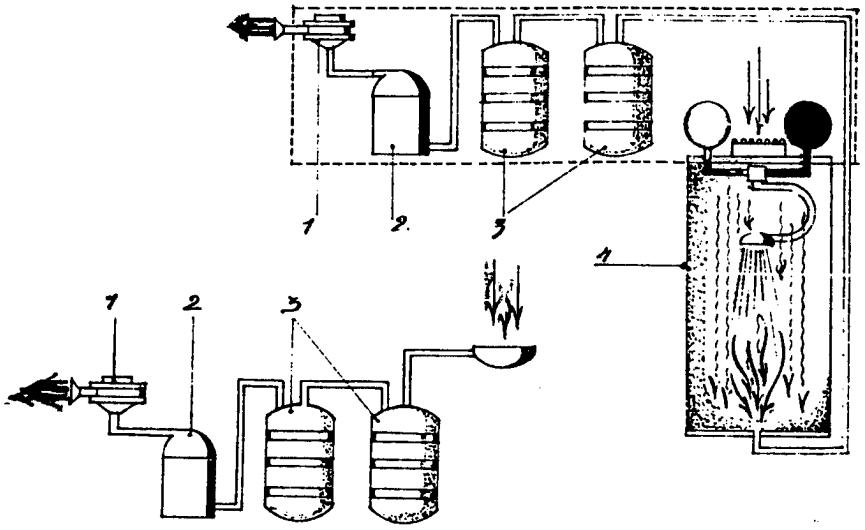
electrical energy produced is then converted into heat in a resistor. By changing the electrical resistance with a rheostat, the physical resistance offered by the pedals can be varied. It is similar to riding a bicycle through hilly terrain.

Five Years Is Not the Limit

The lifetime of the first resupplied station (Salyut-6) was just under five years. By comparison, Salyut-4, the record holder for first-generation stations, stayed in orbit a little longer than two years. Salyut-7 has been circling since April 1982. Mir, launched into orbit in February 1986, promises to break all records for manned flight. On the average, a transport craft docks with it every three and a half months, and a Progress cargo craft docks with it every every one and a half months.

But it's not well-planned supply or advanced design that keeps these orbital stations up so long. Primarily, it is the cosmonauts themselves. Who, if not they, can look after a home in space?

When Salyut-7 was flying in automatic mode, its batteries became disconnected from the solar panels. Because of problems in the command radio link, we couldn't intervene in the operation of the electrical power-supply system, and the batteries ran down. De-energized, the station began to freeze. V. A. Dzhanibekov and V. P. Savinykh went to the station not as cosmonaut-researchers, but as repairmen. The struggle to revive Salyut-7 lasted 11 days. On the twelfth day, all its systems started working normally.



Space shower and sanitation system. A pump (1) forces a flow of air through them. After filtration (2), the air is returned to the station's atmosphere, and full waste collectors (3) are replaced with new ones and removed from the station. A collapsible shower bag with a waterproof zipper is stored after use.

A few words about the exercise equipment. It takes up some space on the station, but it enables the cosmonauts to do various exercises and work virtually all muscle groups. The treadmill is a compact, electric-motor-driven belt. The individual moves his legs on it, working the same muscles he works when walking or running on earth. The secret is that rubber cords hold him to the treadmill. Those same cords pass through rollers to the ceiling of the station and are connected to a "horizontal bar/barbell"—you can do track and field or weighlifting. It is also possible to ride a "bicycle" (a bicycle ergometer). Its pedals drive a generator. The

There are many cases of a second (third, fourth and fifth) birth for orbital stations. V. V. Lyakhov and V. V.

Ryumin, for example, repaired Salyut-6's propulsion system during their mission aboard the station. A leak in the bellows in one of the propellant tanks threatened to cause the engine to fail as a result of chemically aggressive fuel entering the pressurization system. L. D. Kizim, O. G. Makarov and G. M. Strekalov had to replace a pump assembly in the temperature control system on Salyut-6. (If the pump block seals had broken, the work module would have begun to fill with a free-floating liquid fully capable of asphyxiating the cosmonauts while they slept.) Such work no longer seems out of the ordinary to us. It's just part of the workday for cosmonauts.

From the editors: Just how good are things in the "home in orbit?" In a discussion with a correspondent from *Izvestiya*, V. A. Shatalov, the head of the Cosmonaut Training Center, made several important comments about the quality of Soviet space programs. Some of them concern orbital stations. Therefore, it would seem to be useful to bring the buoyant tone of this article somewhat down to earth with his opinion—in particular, that the stage in which "pure science" experiments were conducted in orbit stretched on intolerably long. After all, according to the logic of development, we should long ago have begun large-scale applied-science work in space.

As they say, they have been waiting three years for what was promised. But that considerable amount of time has already passed, and only two of the six docking ports on Mir have been tried out. The others are still waiting for the special modules that the press hurried to dub as "factories in orbit." In reality, what we have is a behind-schedule space construction project, to use Vladimir Aleksandrovich's vivid phrase.

Maybe it isn't so easy to live in a station crammed with scientific equipment. Perhaps we shouldn't compare its cubic space with the usable space in a space craft (just as we shouldn't compare gross industrial indicators to the 1913 level). It would be better to enter a frank discussion of to what degree our space programs have met society's expectations. We await your opinions, readers.

Large Communications Satellites Proposed for 'Energiya' Launch

907Q0024A Moscow IZVESTIYA in Russian
16 Nov 89 First Edition p 6

[B. Konovalov and S. Leskov report: "Energiya for the Entire Planet. Operating on 1.5 Million Channels, an Automatic Telephone Exchange in Space Will Solve the Problems of Telephone Communications on Earth"]

[Text] The first official visit of journalists to the legendary Korolev Design Bureau, known from many newspaper reportages and now part of the Energiya Scientific-Production Association, took place on 14 November. The general director, corresponding member of the USSR Academy of Sciences Yu.P. Semenov, reported that the second launch of the Energiya launch vehicle and the Buran orbital vehicle, developed here in cooperation with other organizations, will take place next year. The most attractive of future projects is a universal space platform capable of insuring the creation of a new global communications system and of providing ecological monitoring of our planet.

How did it come about that a group of space institutes and enterprises came into being in the quiet settlement of dachas at Podlipki near Moscow? In 1920 the Petrograd Weapons Plant, founded way back in 1866 and where M.I. Kalinin at one time worked, was evacuated there to the former property of the tea magnate Perlov. Series production of tank guns and antitank and antiaircraft guns was organized there. In 1938 the settlement of Podlipki became the city of Kaliningrad. And from 1946 its development was associated with the name of S.P. Korolev and space vehicle technology. It was here that the first series- produced Soviet rockets, satellites, space vehicles, and orbital stations were developed and created.

One of S.P. Korolev's closest associates, Hero of Socialist Labor and corresponding member of the USSR Academy of Sciences B.Ye. Chertok, recalls that the first Soviet Molniya-1 satellite was developed at the enterprise. And now specialists at the scientific-production association are proposing to use the powerful Energiya carrier to solve the problem of communications in our country, which in this field lags 10 or 15 years behind the developed countries. As an example: in the non-Chernozem zone alone there are 20,000 populated points that have no means of communication, not even a telephone. According to calculations done by the Ministry of Communications, solving the problem using traditional methods will require and astronomical sum—R60 billion. But the development of space communications will be tens of times cheaper and there will be a sharp increase in the rates at which the system itself is developed.

But this is the problem: Which way to go? In the West they prefer to use high-quality electronics to develop small specialized satellites with an orbital life of 10 to 15 years. There are already two international commercial satellite communications systems. The INTELSAT satellites are for transmitting television programs and communications with stationary targets. The INMARSAT system serves the world fleets and others in movement, right down to people driving ordinary cars. In the USSR a national system has been developed for communications via satellites. The overwhelming majority of them were developed under the leadership of Academician M.F. Reshetnev, who heads the Scientific-Production Association of Applied Mechanics in Krasnoyarsk. He is also proposing further development of this system by evolution, gradually replacing existing satellites with more advanced ones.

But specialists at the Energiya Scientific-Production Association want to make a revolutionary leap forward in the development of space communications. The Proton carrier vehicle, which at present is used to place communications satellites in geostationary orbits, can deliver a payload of 2.4 tonnes. And this means that to develop a space communications system requires many satellites. The imperfect nature of our electronics limits the life of the satellites to 3 to 5 years. Consequently, frequent replacements in orbit are often required, and as a result there is a large number of Proton launches.

The Energiya carrier vehicle with an additional booster, which is now being developed at the scientific-production association, will make it possible to loft a significantly larger payload into geostationary orbit—18 tonnes—and create large universal platforms to replace several ordinary satellites. A large-diameter antenna measuring 30 meters could be installed on this platform and this will make it possible to simplify and reduce the cost of ground reception equipment. Even today the fantastic possibility of setting up personal communications with individual people via a device the size of a wrist watch is opening up. But what is even more important is that thanks to the large weight reserve on the platform it is possible to triple the systems and even with our electronics achieve a service life of 10 years.

The deputy general director of the USSR Ministry of Communications Kvazar Scientific-Production Association, Ye.F. Kamnev, acquainted the journalists with the comparative analysis of different versions for using geostationary platforms. They can be used to support direct multiprogram television broadcasting to small antennas, telephone, telegraph, and facsimile communications via 1.5 million channels, and communications with stationary or moving targets, and for communications with moving ships, trains, and cars, and expeditions located in regions difficult of access. There is one version that makes comprehensive use of all three scenarios. Analysis shows that despite the large initial costs the system will provide a good return.

The conversion now taking place in the country will in principle also provide the capacities required to develop both the space and the ground equipment. But international cooperation and joint-venture enterprises with foreign companies will greatly accelerate the business

and would make it possible to obtain even greater returns by using high-quality electronics.

However, large geostationary platforms do have an "Achilles' heel." A complex system also means complex guidance and cumbersome auxiliary systems. The main thing is that the loss in case of an accident during launch or early loss of work capacity when the platform is in orbit would be too great. And so the USSR Council of Ministers is also organizing a competition for projects (apparently the first in the history of space exploration) for the space communications system of the future. A comprehensive analysis will be made to determine which project is considered the best.

But Yu.P. Semenov is convinced that large geostationary platforms are promising and that if no government subsidies are available he is ready (and this is definitely a first) to take a bank loan to realize the project. In any event, the Energiya Scientific-Production Association plans in 3 years to carry out a demonstration launch of a large geostationary platform so that all states in the world can become aware of its unique capabilities.

Any discussion of conversion at the Energiya Scientific-Production Association would be incomplete is we limited ourselves only to satellite communications systems, promising as they are. At the head space design bureau work has started on prostheses, and a shop for this has already been set up. The suffering of our disabled people and the powerlessness of the enterprises that are designed directly to help them are well known. During the 6 weeks of work on the new discipline at the Energiya Scientific-Production Association, models of prostheses made from space materials have already been developed to imitate the step movement and bending of the foot. The plan for the scientific-production association is 350,000 to 400,000 prostheses each year, and also the organization throughout the country of permanent and mobile centers for individual fitting of prostheses.

Advantages of Proposed 'Energiya'-Launched Communications Satellite Systems

907Q0014 Moscow PRAVITELSTVENNYY VESTNIK in Russian No 21 Oct 89 p 12

[Article by Doctor of Technical Sciences Professor Ye. Kamnev, Doctor of Technical Sciences Professor A. Rodimov, USSR Academy of Sciences Corresponding Member Yu. Semenov, and USSR Academy of Sciences Corresponding Member B. Chertok, under the rubric "At the Government's Initiative": "One and a Half Million People Will Be Able to Talk on the Telephone Via the Satellite-Based Relay Station"; two letters to the editor and an editorial comment, all in italic, precede the text of the article; a sidebar to the article appears in boldface in the original and in the translation]

[Text] *"I am deeply disturbed by the fact that our space program, the most advance program we have in terms of equipment and technology, is in serious danger because of budget cuts. And this is going on at a time when we urgently need research efforts capable of competing on the world market. Let's take a look at the benefits we gain by economizing in this fashion Fine, launch one satellite instead of two. But how much research will be cancelled, and how much less technology will we develop? The money freed up by this will be transferred to fields in which the facilities are weak and the work poorly organized. Where is the guarantee that the return will be what we expect? Or that there will be any return at all? The questions are quite controversial, indeed.*

"Much has already been said and written about what the system of organizations involved in the space program has to offer the country. But there hasn't been enough breadth and persuasiveness to that information. The people talking about cutting funds for the space programs are short-sighted people who have strayed outside their area of expertise."

V. Onis

Arsenyev, Maritime Kray

"And so, another manned mission has begun. As if it hasn't been said in the press and in the Congress of People's Deputies that we need to cut back on space expenditures—because only a rich country can afford them. And what do we have? Empty shelves in the stores, and waiting lists several years long just to get an apartment or have a telephone installed. And without a telephone, the elderly are cut off from the world—if anything were to happen, you couldn't even call the emergency medical squad. And now ration cards have been introduced even for sugar, and you can't buy soap, but we're still launching spacecraft and satellites."

V. Yegorov

Moscow

Two letters—two diametrically opposing points of view. And as paradoxical as it might seem, both readers are, in their own way, right. V. Onis has a point when he says we need to promote the contribution the space program makes to our economic development more vigorously—that contribution is by no means small. And as for bringing telephones into homes, our country has, at the behest of the government, undertaken the development of a promising space-based communications system. We asked some specialists to tell us about that system.

Telephone service (especially intercity service) in this country is poor. There are too many places that are anywhere from difficult to impossible to reach by telephone. This isn't surprising, given the immense size of our country, and depending primarily on cable links when developing trunk lines does not provide much hope for a quick solution to the problem. Too much cable would need to be laid, with amplifiers every 1.5-2 kilometers. Realistically, we couldn't we couldn't use cable to create advanced trunk lines in the deserts of Central Asia or in the vast expanses of Siberia and the Soviet Far East. So what can we do?

Specialists around the world are now showing a preference for space-based communications systems, because such systems are not hindered by distances or by swamps, forests, fields, or rivers. Systems of this type have also been developed and are currently in use in this country, but they still make up only a small fraction of the trunk lines. This is due to the limited traffic capacity of our communications satellites. A Proton rocket can put a satellite of more than 2.5 tons into geostationary orbit. Such a satellite can provide thousands of channels, but that's not enough—there is still a large shortfall.

This extremely severe problem can be solved only by using the space program—that same space program whose "uselessness" has been talked about and written about so much recently. How? Don't forget that we have the Energiya rocket—the most powerful launch vehicle in the world.

Detailed design studies have shown that if the Energiya rocket were fitted with a third stage (a boost stage), it would then be possible to place satellites weighing as much as 18 tons into geostationary orbit. In studying the prospects of the practical application of such unique capabilities, space technology specialists, communications engineers, and radio and television engineers have come to the conclusion that our country could soon make an immense step forward in the development of a new domestic communications infrastructure and could reach new heights in terms of international, commercially viable, global information-exchange systems.

The standardized space platform (SSP) would carry the space-based segment of such systems. The 18-ton mass of such a platform would enable us to have relay stations in geostationary orbit with information and energy capacities dozens of times larger than those not only of existing relay stations, but also of the relay stations that could appear abroad in the next ten years.

What are the advantages of such a platform? It can be fitted with a powerful solar-energy electrical power supply system (no less than 20 kW); highly accurate navigation, stabilization, and attitude-control systems for pointing multibeam antenna systems at the desired region of the Earth's surface. Approximately half of the 18-tons would consist of the relay equipment and antenna. Naturally, a large platform can hold a large number of relay stations for various wavelengths, and the use of multibeam antennas increases traffic capacity considerably. If need be, each of the antennas can be aimed with great accuracy (using either an independent program or by means of commands from the ground) at any region of the Earth's surface experiencing a peak load with its communications links.

There is, of course, one "but"—our domestic communications satellites have an active lifetime of, at most, three years. American and European satellites can both remain in operation for 7-10 years, and in the future, their lifetimes are expected to grow to 15 years. Our lag is due to the unreliability of our components. And until our electronics industry can start providing components with a service life of ten years or more, the vitally important onboard systems on the platform will have to have one, two, or, in extremely crucial systems, even three backups. Of course, that will make the platforms more expensive, but saving money at the expense of reliability would be to no one's benefit.

Plans call for modularizing the SSPs. An automated service module equipped with artificial intelligence and manipulator arms is expected to be developed over the next 10-15 years. In geostationary orbit, such a robot would replace modules and units that had failed or were operating beyond the term of their service life. That would enable us to increase the lifetime of a space-based telephone station to 15 years or more, through modernization as well as repair. In that case, it would be possible to use the cheaper Proton rockets instead of the Energiya rockets. Finally, such an impressive platform could also carry instruments for ecological monitoring and remote sensing of the Earth, in addition to the communications equipment. Since powerful data systems would already be on board, reports could be transmitted to Earth in real time.

Of course, corresponding ground-based systems would also have to be developed in order to handle these multifunctional space platforms. And that's not easy, either—it would require a detailed critical analysis of the problems of systems integration of the space-based and ground-based equipment. Such research has been carried out by scientists and engineers at space-industry organizations and associated enterprises in cooperation with the scientific staff of a number of sector scientific research institutes, institutes under the USSR Academy of Sciences, and universities. The optimum design turned out to consist of three systems with three types of specialized satellites based on the universal space platform—a system for supplying the country with telephone service, another for handling tasks associated with data transmission, and, finally, a system for television and stereo radio transmission. Two platforms would support each of the three systems.

The specific traffic capacity of such a telephone communications system would be approximately one and a half million digital channels. Two SSPs in such a system could serve as many as 150 million telephones.

Would such a space-based communications system be profitable? Judge for yourself. Expanding the trunk lines in the country's unified automated communications system by a factor of 2.5 within the next decade would cost some ten billion rubles. Satellite radio channels would make it possible to expand the system 10-fold, at an expense of about 5 billion rubles, 1.8 billion rubles of which would go for development, construction and operation of the space-based communications system—including the costs for development of the boost stage and 600 ground-based stations. A similar expansion of the trunk lines with the traditional approach would

require approximately 40 billion rubles. Now there is payoff from the Energiya rocket!

In addition to the transmission of telephone signals, a space-based system based on SSPs could also be used for such tasks as the exchange of television and radio programs between oblasts and republics, the transmission of large quantities of data between computer centers, and setting up teleconferences. Some of the communications channels could be leased by organizations at rates 50-100 times below those currently available.

Within five to six years, using SSPs, we should be able to develop a space-based communications system with integrated services for managing the national economy at every level, all the way down to the rayon center. Such a system could serve over 1 million subscribers. Inexpensive miniature terminals could be installed on airplanes, trains, cars and trucks and could be carried on geological expeditions. This would enable us to completely solve the problem of managing air, railroad, and highway transportation, as well as provide communications during disasters and set up an environmental monitoring system.

Developing a system for direct radio and television broadcasting would enable any part of the country to receive as many as eight television channels and 16 stereo radio channels.

The extremely large traffic capacity of communications systems, data transmission systems, and television and radio broadcasting systems based on all-purpose space platforms would guarantee that they would pay for themselves in a relatively short period of time. Moreover, by adding one or two platforms in each subsystem, this country could also approach the foreign market. Calculations indicate that an income of several billion dollars could be obtained from the leasing of communications channels. There's your "unprofitable" space program.

FACTS AND FIGURES [sidebar]

The United States and the USSR developed space-based communications and television systems at almost the same time—the Soviet Molniya-1 satellite and the American Intelsat-1 satellite were placed into orbit in 1965.

Some 50 space-based communications systems (commercial and military) belonging to 25 countries and international commercial consortiums are currently in operation in the world. The number of satellites in the only geostationary orbit for the entire world exceed 110—a figure that does not include the hundreds of satellites that have already "gone silent."

The United States, France, Canada, Australia, China, India, Indonesia, Brazil, Argentina, and several Arab countries in the Middle East all believe that it is advantageous to make extensive use of space-based communications systems to develop their communications infrastructure.

Under previously adopted plans, space-based channels will account for no more than 3% of communications channels in the USSR by the year 2005.

First place in the economically profitable use of communications satellites belongs to the US, which realized an income of more than $2 billion from the use of space-based communications systems in 1987. The United States expects to increase its commercial profit at least four- or fivefold by the end of this century.

Problems Facing Communications Satellite Program Viewed

PM3011144189 Moscow PRAVDA in Russian 13 Nov 89 Second Edition pp 1, 3

[Report by special correspondent N. Krivomazov and TASS correspondent Yu. Khots under the rubric "Top Secret": "'Granit' Is Not Stone: Don't Crush It!"]

[Excerpts] Krasnoyarsk Kray—[Passage omitted] The Sayany marble deposit resembles an Italian one. You could even sculpt a Venus from such marble. But when it was decided to dam the Yenisey in these parts, a road was needed. Blasts began ringing out over the splendid marble. Drillers broke up the age-old strata and scarred the deposit. On the other hand, much rubble was obtained and used to pave the road to the hydroelectric station....

Is there not a risk of something similar happening with conversion, the thought occurred to us on the way to the "forbidden city." This is the name given to this Siberian city, which is not marked on the map. Would we not break up the mighty stratum which, say what you like, has taken shape in the military-industrial complex? Would we not once again pave our road with golden "rubble"? And would we not find ourselves left at the side of the road as the result of misunderstood conversion? [Passage omitted]

Practically all communications satellites came into being right here, on the Yenisey.

It was here that the national satellite television system—satellites of the "Molniya" series—was created. The almost 100 "Orbita" ground stations operating in the country were conceived in Siberia. As well as the "Gorizont" satellite, created for the 1980 Olympics. Thanks to it, more than 1.5 billion of the planet's inhabitants watched Moscow through "Yenisey eyes." Last year alone, according to USSR Communications Ministry data, the saving made as a result of operating satellite communications systems totaled more than R500 million.

"Strange as it may seem, the at-first-glance costly space communications systems are the cheapest and, perhaps, the only correct way to save public money," A. Kozlov, first deputy general designer and general director, entered the conversation. "For example, satellite systems make it possible to read PRAVDA in Krasnoyarsk

almost sooner than in Moscow. Or let's take navigational safety systems. Thus, 'Glonass' ('Global Navigation Satellite System') ensures that one's position can be determined with an accuracy as good as 100 meters at any point on the world's surface. A special system has even been created to observe the wavering of the earth's axis, in order to make the necessary adjustments. When creating such systems we have to study many questions and physical phenomena. For example, the phenomenon of electrifying a satellite. The need to calibrate the orbit. Account is even taken of solar pressure...."

Then came a pause, which the shop chief took advantage of to bring us back down to earth.

"We are only on the approaches to truly modern communications," he began. "We are still struggling with the telephones. To ring my mother in Dimitrovgrad I have to go the post office a week in advance at 0500 hours to book the call."

"I dare say your mother will forgive you," Deputy General Designer A. Kozlov commented. "But how can we explain things to outsiders? For example, we were at the USSR State Bank. In the world at large it takes up to 15 minutes to conclude one banking operation, whereas it takes us 15 days to finalize everything. I asked the State Bank chairman how much such inefficiency costs us, and I heard: Billions of rubles! This means that new satellites and new communications channels are needed."

Or another example.

The "Energiya" carrier rocket is a large rocket, a "tsar-rocket," as A. Kozlov called it. And here he reminded us that the Tsar-cannon has never been fired and the Tsar-bell never rung. But here the thing has been done: "Energiya" has been created. This means a Tsar-satellite must be attached to it, does it not? And then the idea emerges of a giant 18-tonne communications satellite to take almost 1 million telephone numbers! "God help us," people in the "forbidden city" say almost with one voice. "How can there be 1 million telephones when here, on earth, there is a shortage of telephone equipment, wires from yard to yard, and ordinary telephone stations? This is the old megalomania, in which there is no place for everyday 'trifles.'"

"In short, you propose coming down to the person?" we asked the general designer, and we heard this reply:

"Going up, rising up to him."

Then let us speak in greater detail about the kind of conversion being called for on the Yenisey today. Because it is impossible to hide the fact that the local economy, which is accustomed to being "doped with weapons," is faced with a process of agonizingly kicking the habit. At the same time the simplest thing for such a "state within a state" is to open its borders and become "like everyone else." But no, "we have no need of such a ball game!" We do not need to fight the rich but to struggle to ensure that there are no poor people.

This is what M. Lubnin, director of the Siberian branch of the Machine Building Technology Scientific Research Institute, says about such difficult topics. What he says is connected with the regular opening up of glasnost and conversion. Krasnoyarsk has just gotten one more educational institution. Some 30 years after it was created here, a so-called higher technical educational institution [VTUZ], whose graduates have provided more than one general designer, has been declassified. It is the Institute of Space Technology.

"Does the new uniform suit the VTUZ, and has it not put it on rather late? And why does it have any need at all for once-fashionable attire which no longer shines with its former brilliance?" M. Lubnin asked. And he himself replied: "The doubts are unfounded. Space technology is the high mark to which the scientific and technical standard of the whole national economy, and machine building above all, must be raised for production of consumer goods and other civilian output.

"That is, we must not lower but raise demands on ourselves and on people. I believe that this concept will suit everyone. Because the overloading of our economy with spending on arms was one of the causes of omissions in the area of expanding the infrastructure and the education system. In general, my military brothers, it is time to pay the debts, as the saying is these days."

The discussion of the "forbidden city's" new economy continued. F. Klimov, deputy general economic director of the science and production association, spoke:

"We are the only enterprise in the country to work from the project through to the finished product and to participate in the operation of communications satellites registered in orbit. By way of comparison, I will say that in the United States approximately 20 firms are involved with communications satellites. Such a monopoly poses a number of questions. We believe that we are finding the answers to them. The point is that production and science have always been two different types of activity. Two types of planning and accountability even exist for them. But how can 'the horse and the timid deer' be harnessed to the same space carriage?

"In the search for such a harness the sector arrived at self-financing. But the Siberians did not want to be 'like everyone else.' So, with the blessing of S. Sitaryan, former deputy chairman of the USSR State Planning Committee, they tackled the second form of economic accountability—6 months before everyone else. And then they took the risk of switching to the lease or, rather, to the lease form of economic accountability, because there is still a long way to go to true leasing in the USSR."

At this point we interrupted Fedor Sergeyevich with, in our view, a risky question: What will happen if "defense" leases from the state its tastiest morsels?

Then F. Klimov began comparing figures for the last and the present half-years. The total volume of work has increased 80 percent. The volume of experimental work has trebled. Consumer goods—50 percent; civilian output—12 times. And all this, we will repeat, in a collective which has never allowed itself indulgences and, to put it mildly, has had extremely strenuous plans. And here is another result. Labor productivity in the shops has increased 10 percent on their own work. Wages? This is the root of everything. For the umpteenth month now no one here has received the bonuses they used to be entitled to. The final reckoning is done on the year's results. Only after settling everything with the state. Taxation is the only worry. A sizable sum is due to everyone at the end of the year. Will the new tax not "eat" into it? Then it will turn out that the new perestroyka legislation will lie like a log in the path of economic progress. And this can on no account be permitted.

As we see, the economy also has its own conversion. This is a profound, deep-seated process, which has been approached extremely seriously here in Siberia. And then comes an increasingly logical movement of thoughts and deeds. Yes, conversion is truly the command of the times. But it is criminal, to say the least, to approach it with a single yardstick. Today funding here has been cut on all counts. Whereas previously all the sisters had earrings, as the saying goes, now each sister has one earring.

We stayed briefly in one of the shops to photograph "Molniya-3." But the designers brushed it aside—old hat, they said. It will hold out for 2 more years, and then it will have to be changed for "Granit." It is also time to add "Gelikon" to "Ekran," whose approximately 6,000 stations enable the inhabitants of the most remote, out-of-the-way corners to receive television programs. The fate of this new communications satellite has been discussed in the Central Committee Politburo—this product is of such significance.

But here is the rub. Who will finance it? The military, whose belt we have tightened, is beginning to shy away from "nonprofile" subjects. The Ministry of Communications will not be equal to a statewide task on its own. The government program is under threat of failure.

"It is necessary to decide, and not 'adopt a decision,' as we have taken to putting it recently." General Designer M. Reshetnev is categorical on this point. "It is necessary without delay to define priorities and publicly renounce a number of subjects, and to devote all our energies to carrying out what is left. Otherwise there will be an immediate slackening of pace, and our whole space chariot will come to a halt. Even if we abandon all topics after "evenly" distributing the cut funds, we will still be unable, like Christ, to feed our world with seven loaves. Today we have built up an unprecedented pace: We can renew output every 3-4 years. Averaged financing will at once double this time to 6-8 years. Is such conversion needed?"

...On taking our leave, we put a final question to Mikhail Fedorovich: Who will have the boldness and the authority to revise the existing programs with regard to each enterprise, not in words but in fact?

This was the only question to which we never received a reply on that day.

Moscow Advertises Offer of Satellite Photos

LD0911203689 Moscow Domestic Service in Russian 1630 GMT 9 Nov 89

["Advertisement"]

[Text] The main center for the reception and processing of satellite information and the regional computing center of the USSR State Committee for Hydrometeorology are offering photographic materials of the surface of the mainland and oceans of our planet gained with the aid of radiophysical and scanning apparatus mounted on board artificial satellites of the "Resurs" system and of the "Okean" type.

Satellite information is destined for use in resolving the most varied national economic tasks and in scientific research on the study of natural resources. Photographs from space represent a unique opportunity for constant monitoring of the ecological situation in any region of the earth and to operationally monitor spring and tundra fires and rivers and reservoirs prone to flooding after rainfall; to determine the condition of agricultural land and the appraisal of the seasonal development of crops; to help fishermen search for catching areas; and for new opportunities in geology and hydrology.

Space photographs will help solve many problems from the most unexpected angles. You can receive information in the form of black and white photoprints, negatives, or in the form of recordings on magnetic tape. The information is processed with the aid of the newest software. By using satellite information you will gain an irreplaceable assistant in your work. Address all questions to the main center for the reception and processing of satellite information at the number 483-41-18 or 483-42-82. I repeat 483-41- 18 or 483-42-82. Satellite information at your service.

'Molniya-3' Satellite Launched 28 November

LD2911093189 Moscow TASS in English 0908 GMT 29 Nov 89

[Text] Moscow November 29 TASS—The Soviet Union launched a communication satellite "Molniya-3", using the "Molniya" rocket booster, on Tuesday to provide for the operation of long-distance telephone and telegraph radio communication and to broadcast Soviet Central TV programs to the Orbita network and the network of international cooperation.

The satellite is in an orbit with a 40,600-kilometer apogee in the northern hemisphere and a 662-kilometer perigee in the southern hemisphere.

The period of satellite rotation is 12 hours 16 minutes and the orbital inclination is 62.5 degrees.

Communication sessions through the satellite will be carried out according to the schedule.

'Raduga' Communications Satellite Launched 15 Dec

LD1612084889 Moscow TASS in English 0840 GMT 16 Dec 89

[Text] Moscow December 16 TASS—A communication satellite was launched by a Proton booster rocket in the Soviet Union on Friday.

The satellite, Raduga, carries relaying equipment intended for ensuring telephone, telegraph and radio communication and transmitting television programs.

The satellite was put into orbit, close to a stationary one, with the the following parameters:

Distance from the earth's surface—36,551 kilometers,
Period of revolution—24 hours 35 degrees,
Inclination of the orbit—1.5 degrees.

The on-board equipment is operating normally. The satellite is controlled by a coordination-and-computer center.

The communication and television equipment will be operated in accordance with a preset program.

'Cosmos-2054' Communications Satellite Launched 27 Dec

LD2812141489 Moscow TASS International Service in Russian 1349 GMT 28 Dec 89

[Text] Moscow, 28 Dec (TASS)—The launch of the latest artificial Earth satellite, "Cosmos-2054," was carried out in the Soviet Union on 27 December 1989, using the "Proton" rocket carrier.

Apparatus to relay telegraph and telephone information in the centimeter-wave range is installed aboard the satellite.

The satellite has been put into a near-stationary orbit with the following parameters:

—distance from the surface of the Earth: 36,436 km;
—inclination to the equator: 1.5 degrees;
—period of revolution: 24 hours, 29 minutes.

Apart from the relaying apparatus, on the satellite there are:
—A radio system for accurately measuring elements of orbit;
—A radio telemetry system for conveying to Earth data about the work of onboard apparatus.

The apparatus installed on the satellite is working normally. A coordinating and computing center is processing the incoming information.

'Molniya-3' Communications Satellite Launched 23 Jan

LD2301161190 Moscow TASS in English 1605 GMT 23 Jan 90

[Text] Moscow January 23 TASS—Using a Molniya booster rocket, the Soviet Union today launched a communications satellite, Molniya-3, to ensure the operation of the remote telephone and telegraph radio communications, transmit Soviet Central Television programs to Orbita network receivers, and promote international cooperation.

The satellite has been placed in the orbit with the following parameters:

—Apogee in the northern hemisphere—38,892 kilometers,
—Perigee in the southern hemisphere—642 km,
—Period of revolution—11 hours 41 minutes,
—Inclination of the orbit—63 degrees.

Communications sessions via Molniya-3 will be conducted in keeping with the flight program.

Glavkosmos Chief Defends Space Budget, Goals

907Q0035A Moscow LITERATURNAYA GAZETA in Russian No 51, 20 Dec 89 p 11

[Interview with Aleksandr Dunayev, chief of USSR Glavkosmos, by scientific observer Oleg Moroz: "Can We Economize on Space?"]

[Text] [Moroz] At first I tried to telephone you on the "private line." Your "private line" secretary, sitting in the Ministry of General Machine Building, spoke in a very friendly manner and said that at that moment you were in Glavkosmos [Main Administration for the Development and Use of Space Technology for the National Economy and Scientific Research]. She advised me to call there using the city telephone. I telephoned. There the conversation was quite different, quite rude. The secretary there said that although you were there she was unwilling to connect me to you, and she talked in this vein: "So many people call here..." (even though I had identified myself as the LITERATURNAYA GAZETA scientific observer and had at least 6 million readers behind me). Is it that this courtesy and friendliness are shown to a "selected" public (who else would use the "private line"?) and the rudeness toward someone "not special" is the usual style of Glavkosmos work?

[Dunayev] How can I answer you? If I say "no" you will not believe me, but I cannot say "yes" because in fact the answer is "no." It is simply a random thing that people in any particular apparatus turn out to be educated in different ways. But rudeness is unforgivable in anyone, and if in fact this occurred as you said it did, then please accept my apologies. One explanation—not an excuse—for this response by the secretary to your call could be the fact that very many people do call, and there are many visitors. We receive about 800 foreigners each year alone and we have only 35 associates. In addition to telephone conversations and receiving guests, we still have our business to carry on. Here I am talking to you on a Saturday, but I also will have to work on Sunday. Lack of order, of course, but how else can it be if 5 days are not enough?

[Moroz] Let us turn to our subject. We have heard many calls recently to cut back spending on space. Does it not in fact seem to you a crime that a country such as ours, where people are short of necessities and where there is a budget deficit—R120 billion—cannot allow itself such spending on space flights? This year some R6.9 billion has been spent on all space programs, an enormous sum, even though people do not really believe that figure. I suspect that the space budget, like the defense budget in the past, is invisibly dispersed to many other areas. In any event the spending is colossal, and this comes at a time when the dregs are being gathered together for low-income pensioners....

[Dunayev] We spend very little on space: This year R1.7 billion is being spent on national economic and scientific tasks, and R1.3 billion on the multi-use "Buran." Well, what of the R6.9 billion? (This figure, I assure you, is reliable.) Set it alongside the losses in national economic output, which according to the scholars is up to R25 billion, or the U.S. space budget of $29.6 billion this year. I am not talking about the ruble-dollar exchange rate, but just citing the figures for a comparison that perhaps says much.

[Moroz] Why compare us with America—a rich and flourishing country, while we are poor....

[Dunayev] I believe that this is clear to everyone that for peace in the world and to maintain the level of security for the country at least at its present level, we must preserve parity—in both civilian space and military space. And to preserve it with such funding! Previously, when we managed to do this, it was primarily thanks to the selfless labor and talent of our engineers, scientists, workers, and production organizers. This was not at all thanks to generous funding. It was not simple. You can compare our military spending in space with this year's figures: R3.9 billion and $22.8 billion.

[Moroz] How much money is proposed for next year?

[Dunayev] The budget envisages a 10 percent reduction. However, some members of the Supreme Soviet have demanded and are demanding even greater cuts in our budget.

[Moroz] Even given that less money is being spent for space, each year our number of launches is at least five times greater than that of the rest of the world. Is this not a paradox?

[Dunayev] A seeming paradox. In order to reduce the number of launches it would be necessary to increase the lifespans of satellites—that is, spend considerable sums on new technology.

But overall we are not launching five times more than the rest of the world. In 1988 we carried out 90 launches, and other countries had 26....

[Moroz] Well fine, something is needed for defense, for the national economy, and for science. But how many costly and ambitious projects have there been whose purpose was merely to show and prove and demonstrate... and now again—an expedition to Mars. Can our unhappy people afford this when they cannot even buy soap? We are talking about tens of billions of rubles! What in general can be said about this now?

[Dunayev] Our proposal for a joint expedition to Mars should be regarded as an alternative to SDI—the notorious Star Wars program. I suggest that there is no need to explain the significance of this. At the same time we should distinguish between two aspects of the "Mars" program—the technical and the economic. As for the technical aspect, if we start work today and combine the efforts of various countries, first and foremost the USSR and the United States, then somewhere around the year 2015 to 2017 it will be possible to make a manned flight to Mars with a crew of three or four. With respect to the

economic aspect, we have always said that this is an enormous, multibillion program. According to union republic estimates, the entire program will cost from R50 billion to R70 billion. The Americans think that it will cost up to $100 billion.

Let me emphasize once again that we have never said that we shall travel to Mars by ourselves. And when M.S. Gorbachev made the proposal to prepare for such a flight he was talking precisely about international cooperation in this field and the need to combine all the minds of the space experts on earth for the sake of this goal.

[Moroz] You have obviously offered appropriate proposals to M.S. Gorbachev. Does it not seem to you that you have placed him in an awkward position, given the economic disorganization that we are experiencing, to talk about a flight to Mars—a flight which requires such a sum, which, of course, will grow as things move ahead and which we must provide half. A total of R50 billion—these are not pennies.

[Dunayev] I do not think that spaceflights are an extravagance. Space research has been, and will be, a powerful incentive for scientific and technical progress. If we apply the brakes in leading sectors then there will be even greater sluggishness in all the others, and, of course, in the economy as a whole. In this sense we have not placed the leadership in an awkward position. The proposal was greeted with understanding throughout the world. It was not detailed, but everyone understood that preparations for the flight are a prolonged process that depends on the state of the economy. Today we are committed to the concept of bringing mankind closer to this goal—a flight to Mars—in line with its material resources. Currently, we first plan to send an unmanned vehicle to Mars in 1994. Some R50 million will be needed for this program in 1990 alone. We are being offered an amount R20 million less for the scientific work, but as for the design work, which should be started right now, we haven't got a single kopeck.

[Moroz] Perhaps the only people's deputy to defend space research at the first Congress of People's Deputies was the economist Professor G. Popov. The essence of his argument was that space research is one of just a few fields where we are ahead, so why not work on it further and develop it more and take advantage of its position to move ahead and derive a commercial profit from it? But this is the opinion of an expert in the humanities and is far removed from the subject of our conversation. Are we in fact ahead in space technology? When they review our space program, experts in the West always unanimously emphasize that it makes use of "quite technologically modest facilities" (but when they praise us this always gives rise to the suspicion that while they approve, they simply are trying to get money for their own space research work)....

[Dunayev] According to the statistics our launch vehicles are the most reliable in the world. The design of the "Energiya" launch vehicle and its engines and the philosophy behind it are very highly assessed in the West... so here we remain competitive. Where we are behind—and experts in the West talk openly about this and we are aware of it—is in computers and service equipment. When it is a question of communications satellites, particularly the length of their useful life, they reproach us for the low level of our microelectronics. But this is our common trouble, not just in space technology.

Right from the start our sector faced a very severe requirement—namely, to develop launch vehicles and space equipment using only Soviet-made developments, materials, equipment, resources, and technology. The United States was in a much more advantageous position: While having its own highly developed industry and unique scientific centers, it was at the same time able to borrow the latest achievements from other countries and recruit eminent foreign experts.

[Moroz] Notwithstanding, what do we have to trade with? What is competitive in the world market?

[Dunayev] We are offering the world community an extensive range of commercial services connected with the use of space technology, and we have achieved this sometimes. But it is not very easy. For example, the most profitable business is in launching communications satellites into geostationary orbits. Each such launch generates an income of about $80 million. Starting in 1986 we have been offering our services in this field to all countries. But the fact is that all satellites in the world have American components, and despite the thaw in relations between our countries, the United States will not give permission to import those satellites into the USSR; there is a tight embargo on technology transfer. So that here what we are talking about is not competition but artificial restrictions set by politicians. There are about 150 communications satellites in the world market, but we cannot launch a single one of them.

[Moroz] As I understand it, our own communications satellites are not as good as foreign ones.

[Dunayev] Yes. The "Gorizont" was built 10 years ago and today is obsolete in terms of some of its parameters....

[Moroz] In general we hear about the unusually high level of space technology. A space vehicle is certainly more advanced than a domestic iron or a vacuum cleaner. But breakdowns in space are not a rarity; just take the recent loss of the two "Phobos" vehicles. How much of the people's money is being wasted?

[Dunayev] The most likely reason for the failure of the final part of the "Phobos" program was the general unreliability of our electronics. But we are not excluding another cause. We had complete knowledge of the situation around the Martian satellite. How do you think such a survey could be made? Was it because the scientists did not tell us that there are hundreds of tons of matter there in a atomized state? Was it because we were

not warned that there is an enormous effect there from the streams of solar radiation, or particularly heavy particles—protons and neutrons?

We are, of course, not absolving ourselves from blame. Given all the circumstances, after the vehicle had lost orientation, we were not able to restore it quickly.

And of course, one final point: In general I do not believe that the "Phobos" program was a failure. The Americans, for example, are suggesting that only one-fourth of the program was not completed. The French are talking about its "very rich results." How was it a failure? A series of unique data of enormous interest to the entire world was obtained.

Regarding domestic irons and vacuum cleaners, the enterprises in our sector are producing irons and vacuum cleaners that are being purchased with satisfaction abroad, for hard currency, at world prices, and output is being increased.

[Moroz] What was the purpose of building the gigantic "Energiya" launch vehicle? What will it carry into space? The feeling is that the only goal being pursued was to surpass the Americans (their launch vehicle of the same class was the Saturn-5). Also, what was the purpose of the "Buran," which is a copy of the shuttle? Again, was it to prove that we are not lagging behind the Americans? We are just showing off what we have done to someone, that is all.

Can it be, do you think, that the world does not see who we really are? It has been calculated that lifting a payload using the "Buran" will be 20 to 40 times more costly than using conventional launch vehicles. Again, why are they necessary?

[Dunayev] The irony is that we have always said that the "Energiya-Buran" system should not be regarded as a transport system ("what will it carry?"); it will be considerably more costly than conventional launch vehicles, and now these very arguments are being used against us: We have made a mistake, they say. We have made no mistake. The "Energiya-Buran" system was conceived primarily for defense purposes and it was deemed quite essential, and all other issues (and you understand this well) were to be secondary.

Does this mean that the system has no peaceful application? It is impossible to imagine that. A great deal has already been said about various versions....

You are comparing "Energiya" to the U.S. Saturn 5 launch vehicle, which can lift about the same payload. Some people also recall the similar N-1 launch vehicle, whose flight tests were halted 15 years ago. How correct are these comparisons? How successful can you be in comparing the "Zhiguli" car with the prewar "Emka," which carried the same weight. The "Energiya" is a new-generation launch vehicle.

[Moroz] The diverse and fantastic applications for the new system lie in the future. But now the "Energiya" and the "Buran" are sitting on earth with no purpose or destination, taking up a pile of the people's immobilized money. Incidentally, how much did they cost?

[Dunayev] During the 13 years of development and building, R14 billion were spent. The cost of the first launch was R350 million. Returning the "Buran" to earth costs R140 million. In other words, the net cost is R210 million. We hope to recoup that money. A start already has been made to return it to the state; 581 proposals have been made to other industrial sectors to introduce the latest technologies, materials, and structures worked on during development of the system. The expected savings from proposals already adopted is hundreds of millions of rubles. Next year we hope to recoup at least R6 billion, and the total R14 billion by the year 2000.

[Moroz] During the launch of gigantic vehicles like the "Energiya" the atmosphere crackles and the ozone layer sizzles. The Americans believe that in order to loft into orbit a vehicle that will fly to Mars it will be necessary to launch the "Energiya" fifteen or twenty times. Are we preparing finally to destroy the earth's atmosphere and resettle on Mars?

Incidentally, there are reports in the West that the "Energiya" may become a stage in an even bigger launch vehicle. The poor ozone layer! Poor people!

[Dunayev] It is primarily nitrogen and chlorine that harm the atmosphere. But we use mainly cryogenic fuels—oxygen and hydrogen, and partly kerosene. These are all ecologically clean fuels. The harm—dreadful harm—comes from launching solid-fuel carrier vehicles. And, as is known, in the United States extensive use is made of solid-fuel rockets and boosters. In a single launch, like the splendid launch of the "Atlantis" that we recently saw on television, hundreds of thousands of tons of ozone are destroyed. About 300 launches of the shuttle each year would be a catastrophe and the ozone would be completely destroyed.

[Moroz] The shuttle, of course, can be criticized. Nevertheless, we are convinced that we need independent ecological inspections, just as in major construction projects.

[Dunayev] I do not object, but I do say with a full and proper sense of responsibility that we are always thinking about the environment and include it in all projects. The newspapers have already written that if we take as a criterion of ecological damage the amount of ozone destroyed per unit of payload, the "Energiya" launch vehicle is cleaner than the shuttle by a factor of about 7,000. True, by the same criterion our other launch vehicle, the "Proton," is about 2.5 times dirtier than the "Energiya," but even it is thousands of times cleaner than launch vehicles such as the "Delta" and the "Ariane" used in the West. The task now is to do further work on the "Proton" to improve environmental safety.

[Moroz] How many "Proton" launches have there now been? Dozens?

[Dunayev] Well, we all grow wiser gradually. When the "Proton" was being developed, environmental issues were not being raised so acutely.

Now the question is whether the "Energiya" will be made larger. The designers are thinking about it, of course. Designers always are thinking about the future. But nothing practical has been done. We think it is too early. This kind of launch vehicle will be needed, we assume, when it is a question of developing a power station in space with fields of solar structures dozens of kilometers long....

[Moroz] Space research emerged as a by-product of the arms race. (One of Kurchatov's associates told me how after the development of the ICBM Korolev went to Kurchatov and, using a globe of the earth, he began to measure intercontinental distances across which a missile could deliver atomic playthings. It was only then that the first satellite appeared.) To what extent today is space research delineated by the solution of military tasks? What percentage of launches are for peaceful purposes?

[Dunayev] I would not say that space research is a by-product of armaments. It would be more accurate to say that both avenues—the dreams of the peaceful opening up of space, and the desire to acquire powerful weapons—have been developed side by side. It is another matter that dreams are the field of the ideal, and the ideal is always weaker than what relies on the down-to-earth, realistic approach. Yes, at the time of the birth of practical space research, immediate defense goals were being given priority. Yes, the first satellite was lofted by a launch vehicle developed as a strategic weapon. But this does not mean that at that moment they were not also looking beyond, to the more remote goals of space work for peaceful purposes.

Now about one-third of our launches are for peaceful purposes, at least in terms of expenditures, and sometimes more (for scientific satellites). The rest are for defense purposes.

This year the proportion of spending for military space purposes is about 56 percent. The direction in which the relations of these figures will go depends not on us and not on those directly involved in space rocket technology, but on trends in the development of big politics and on the success or failure in disarmament negotiations.

[Moroz] Tsiolkovskiy and the science fiction writers dreamed about space flight as about some kind of radiant, festive thing that elevated the soul. Today it must be recognized that this is not the case. Space research is a half-hidden, arcane, buttoned-up affair occupied by the undertaking's tedious officials. An undertaking shrouded in total secrecy and guarded by draconian censorship that stands apart from Glavlit [Main Administration for Safeguarding State Secrets in the Press], until just recently allowed through, literally as if through a filter, only light of a rose-colored hue. Will there be changes here?

[Dunayev] Real life is always distinguished from what the science fiction writers dream. In one sense it is also tedious and gray. But man has always been able to make out the bright colors in it. More so in space research. We have now simply forgotten what a festival it was not so long ago for millions of people. We have forgotten because today it has become a routine matter.

With reference to glasnost, we have started to develop it through a number of firsts, particularly since the first joint missions. They have talked openly everywhere about what we are doing. Over the years the veil of secrecy has become less and less. Today we can read about our unsuccessful moon program and about the N-1 rocket, about the various undertakings in the sector and about its leading scientists and experts. Finally, we have familiarized journalists with the program for the development of space research for the period from 1991 to 2005. (Incidentally, the accusations made against us that in the past we had no long-term space programs are ridiculous: Some of those who today are leveling these accusations have themselves, among others, subscribed to those programs, like annual and 5-year plans, and have evidently forgotten about it.)

In the field of so-called censorship none of those writing about space research have any problems at all. For the last 1 and ½ to 2 years we have been concerned with only one thing: To prevent, if you will excuse me, the telling of many lies about historical and technical details. It is annoying when people lie.

[Moroz] Do you maintain a special censorship department merely to catch blunders? In this case you must extend censorship to all subjects—physics, chemistry, history, geography, international affairs, for blunders also occur there.

[Dunayev] We are prepared to provide information just as openly as the Americans do. They report everything in detail: Today at such-and-such a time the shuttle was launched, at such-and-such a time a malfunction occurred in a particular system and such-and-such steps were taken. We have recently begun providing similar information, but nevertheless we should not forget that there are still state, military, and commercial secrets....

[Moroz] For a long time space flights were depicted by our propaganda as nonstop heroics designed to lift the people's spirits. It is not clear, however, which contribution was greater—raising the spirits or lowering morality. Everyone can see that space research is used by many people for career advances. Almost everyone who has been in space has very soon afterward moved swiftly up the professional ladder. Almost all the military people have become generals and colonels (even Tereshkova is an Air Force colonel!), and the "civilians" have been given posts the equivalent of general "in civilian life."

But why, precisely? Is it because a person who has satisfied the requirements of space research also immediately meets the requirements of selection for the duties of a leader? Take that same Tereshkova, for example. She flew in space a quarter of a century ago. She felt poorly during the mission and was able to do almost nothing worthwhile. But her career since then has been dizzying, and she has been seated in presidiums continuously for more than 20 years. If one were to ask what she has accomplished that has been so outstanding in those leading posts, almost no one could answer (her own recent interview in ARGUMENTY I FAKTY clarified very little). Need we be surprised that the people who are rushing to get into space research, including by taking advantage of favoritism, include many besides those who are eager for interesting work or romanticism. Moreover, have not former cosmonauts in some cases been employed in posts that would have been more suited to others?

[Dunayev] Here I disagree with you. In my opinion your accusations can be applied least of all to space research, in just the same way, I hope, as it applies to your colleague journalists who want to fly in space. Not least because you do not become healthy by someone using influence on your behalf. These are the statistics: Only one candidate is selected from about each 100 contenders. I can state that the overwhelming majority of cosmonauts are highly qualified specialists, people with a broad outlook, knowledge, and experience. If some of them, but by no means all of them, have "made a career" in the good sense of the word, then this is regular and justified. Good examples are Shatalov, Yeliseyev, Ryumin, Solovyev, Polyakov, Savinykh, and many others. I know our cosmonauts well, and the civilians, of course, better, and I can assure you that they are suitable people.

Some 15 cosmonauts are now working in the Glavkosmos system. Of these, five are test people, two are sector deputy chiefs, three are complex deputy chiefs. All of them have God only knows what kind of major duties. The others include a complex leader and a services leader and deputy leader, a deputy chief designer, and finally a deputy general designer. I can tell you directly that we make appointments according to brains and abilities. And this rapid advancement? If a person has worked for 20 or 30 years how can he not be a sector deputy chief? Talk with Solovyev, Ryumin, Aleksandrov, and Lebedev. Assess their levels. Or take those who have left us. Yeliseyev was elected vice chancellor of the Moscow Higher Technical School in the face of great opposition. Savinykh was elected vice chancellor of the Moscow Institute of Engineers of Geodesy, Aerial Photography, and Cartography. Aksenov was selected from three candidates for the post of director of the State Committee for Hydrometeorology's GOSNITSIPR [State Scientific-Research Center for Study of Natural Resources]. I was sorry to lose all of them, they are all fine workers.

It only seems that the life of a cosmonaut is paradise when they receive the awards and appear on television. In fact each mission is a definite risk, and very hard work. Also, life is not any easier after the mission. In addition, like all of us, they are busy with their own basic work, but they still have their public work. This must also be maintained, and it is. True, some of them sometimes show symptoms of the star sickness.

[Moroz] Do you allow criticism?

[Dunayev] A strange question. Of course.

[Moroz] In 1986 I did a feature story on Feoktistov that was published in LITERATURNAYA GAZETA. In my opinion, he is one of the most interesting and nonconformist people in space research. In the story I cited his words on how difficult it is for space designers to live: "Here coming up with something substantial is just a small part of the problem. Then you spend 90% or 95% of your energy convincing people that it must be done, so that the whole business is not ruined along the way. Moreover, the ladder above you to the leadership is so tall. Everyone wants to have his finger in the pie."

These words were deleted by your departmental censor, but I deliberately used them. What was the reaction? After publication the chiefs simply banned Feoktistov from appearing in print. There is your criticism!

[Dunayev] I do not recall that ban, but.... There are different chiefs. Some accept criticism normally, others do not. I would not make too broad a generalization out of this case.

In conclusion I would like to return to the basic subject of our conversation—to spending for space research. For us here in the motherland of space research a need has suddenly arisen to prove that space research is needed and that even today spending on it should be maintained at least at today's level. This issue has arisen nowhere else, not even in the developing countries. With respect to the developed countries, they spare no money and it is largely thanks to this that the high living standards of their populations are insured.

Today, space has entered so firmly into our lives that we no longer notice that we make use of its services every day. Satellite communications, navigational, meteorological, and ecological monitoring systems are all a result of space research. The hotheads who are demanding sharp spending cuts in space research evidently have no idea of what is entailed in reducing allocations for all this and for the many other national economy space systems, with all the consequences stemming from it. Is this wise? For all the people will immediately start to feel it.

Conditions at City of Leninsk Described, More Openness Urged

18660216 Moscow KOMSOMOLSKAYA PRAVDA in Russian 13 Sep 89 p 4

[Article by KOMSOMOLSKAYA PRAVDA correspondent A. Lapin, with dateline of Leninsk, Kzyl-Orda

Oblast: "The 'Burans' and the Shaft Diggers: Report From a City That's Not on the Map"]

[Text] The paved asphalt road led directly to the check point. To a spot that, beyond a long gray concrete wall stretching from horizon to horizon, represented the destination of the trip. During the stagnant times they wrote of it as the "Gates into space!" And now I was knocking at those gates. But soldiers sweltering in the heat in "summer" field uniforms demanded a pass.

I didn't have one.

While they were deciding in town who would meet me, I checked out a hypothesis: if there's a wall, there must be a hole in it. Soon the hypothesis was confirmed. About five hundred meters away I saw another set of "gates" made of a pile of slabs. A herd of cows, peacefully nibbling at the grass, stretched through them toward the city.

And no one was stopping them.

So the concrete wall, the pass system, the soldiers at the check point, the special permission to stay at the hotel—all this was no more than the stage set for a play called The Regime.

Then why were the appropriate organs interested in tracing my relatives practically seven generations back? Filling out the form, I remembered with alarm that my father's aunt twice-removed had gone to Australia in 1909. What is standing guard over the Regime if, for example, last year a hard-core criminal got into the city last year and killed a policeman with a gun? And foreign cosmonauts live here, journalists travel here and even the President of France was here?

After I got past the wall, I looked for an answer to these questions for a long time. But the hotel was quite ordinary. It had mosquitos and a broken-down refrigerator. Walking around town gave no answers, either. An austere, humdrum, ordinary life went on around me. In the department store there was a long line for buttons. In the food store, the clerk, looking me in the eye, hurriedly warned me: "Meat and evaporated milk with coupons."

In general, everything was normal. Possibly just a little better than in neighboring state farms.

By evening, I began to understand. First, this paucity of supplies protects the Regime. Second, those who work for the Regime need it. Imagine how many people make a living from that which creates difficulties for the city people and guests.

They check documents, make demands, give permission.

And everybody gets paid well. With raises.

In general, though, this was a strange settlement. Not long ago, for example, it noted its thirty-fifth anniversary. It was the anniversary of a town that doesn't exist. You don't believe it? Look on any map. You won't find a Leninsk anywhere.

Last year, its residents finally found out how many of them are here. From the President of France.

For a long time I searched for a name for this phenomenon that exists only, perhaps, in our country. And at last I found it.

A departmental city.

Most cities are born out of love. People find a place that they like. They settle there. And live there. Departmental towns appear out of severe need and decree. The country needs uranium, and Shevchenko springs up on the shore of the Caspian. Novyy Uzen sprouts up on oil; Bratsk, on a hydroelectric station. How many of these settlements have been born in recent years in our country, nobody knows. Certainly, they number in the hundreds.

And in the very same way, Leninsk was born near the Baykonur Cosmodrome, in the sands of the Kzyl-Orda Oblast.

That's when the country needed a space shield. The desert on the banks of the Syr Darya River, not far from a railroad branch-line, seemed to be a strategically advantageous spot. Moreover, it was near the equator. And the rotation of the Earth promised additional acceleration for a rocket.

"In those days," says the first secretary of the city party committee, Vladimir Georgiyevich Savchenko, "the objectives before us also determined the ideology of the city. It was necessary to bring in half-finished rockets, assemble them here, prepare them for launch, and launch them. It was felt that there was no reason to do any major construction around here. The officers sent here for a tour of duty were a hardy lot. They would survive. The decision was made from above."

That's how the barracks-city was born.

Years went by. The ballistic missiles were lowered into their launch tubes. Spacecraft took their place. Gradually, the objectives and the programs began to change. Along with inter-city telephone, new television programs, and weather reports, peace-time space came into every home. After the military, civilian specialists came here one after another.

"Young lieutenants arriving in the fifties became generals," says Sasha Korbitsyn, first secretary of the city Komsomol committee. "They had children, and then grandchildren. A new generation sprang up in Leninsk. And many of those same people went to work at the launch pads."

I dropped into the bakery in the evening. There were none of the usual loaves or rolls. In the trays were

nothing but true soldier's bread. Heavy, gray, and smelling of nothing. I asked the clerk about loaves and rolls.

"They are a rarity here," she answered. "So you'll have to take what we've got."

In bread making, just as in the city's municipal services, the key figures aren't the master bakers, much less the streetcleaners or the garbagemen, but the soldiers. Consider that there are a great many dormitories among the city's housing. The waiting list for kindergarten is eight years. And the water supply sometimes has water that is pumped directly from the Syr Darya...One can see what trifles the life of the "conquerors of space" is made of.

By the way, this is the situation in many departmental cities. And frequently, they die as soon as what gave birth to their wealth is exhausted. That's why they're not built up. But Leninsk, judging from everything, has a long life ahead of it. And in order for the city to develop normally, it should have a good municipal services, commerce, supply, and civilian organs of authority. But today, the picture is like this. There's two of everything in Leninsk. Two party and Komsomol organizations—military and civilian, two commerce systems, two sets of municipal services, and so on. On the one hand, there is the military department, which "has the resources—equipment, money, and manpower." On the other hand, there is the civilian organs, which have neither the first, nor the second, nor the third.

"Life is set up that way," explains the secretary of the Komsomol committee of the Progress plant, Yuriy Dorogobit. "We sit here, and wait for an apartment in Kuybyshev. At the head enterprise. Once every six months we go there, re-register for the temporary duty assignment [TDY], and we're back."

For those on TDY, that is the beauty and the pain of the "space harbor." There are people who have been on TDY here with their families for some twenty years. In Leninsk they live in apartments that the departments rent and pay for. Usually they and their wives receive not only a wage, but also expense allowances. And in their homeland, permanent housing, empty, awaits them.

In addition, there is another category of people on TDY. They live in dormitories right at the launch pads. One could not call their daily lives comfortable in the least. The panelled five story buildings turn into steam baths in summer, glaciers in winter.

From a material point of view, being on TDY is profitable. But at times it becomes absurd. If a visiting specialist marries a local, he loses his expense allowances. So some just live together, without registering.

The diversion of resources for departmental needs and the feeling of temporariness create other problems, too.

"Even crime is special for us," says the city's public prosecutor, Ye. V. Syromkin. "It's like a train station. Judge for yourself. On the road where I live there are sixteen apartments. In six years, the list of occupants has changed completely. Only two original families remain. In general, there are no permanent human ties. Thus, the scourge of the city is the apartment dwellers and the theft of personal property."

They say that when the French went from Leninsk to the launch pads, in disbelief they kept asking those assigned to accompany them: "Aren't we travelling on a side road?"

They couldn't believe that that strip of concrete, broken up by wheels, with the reinforcing rods sticking up out of the roadbed, was the main road to the cosmodrome. They thought that they were begin taken on a detour so some secrets wouldn't be revealed.

We went to No. 2, the oldest launch pad at the cosmodrome. The sentry lifted the barrier, and there we were near the pad. Senior lieutenant Mikhail Semenov spoke with pride about the launch pad: "At one time, Gagarin lifted off from it."

The cosmodrome museum is in the military part. The museum also houses the cottages of Korolev and Gagarin.

I walked through the deserted halls of this small museum, and listened to the guide. And thought. The space programs were paid for by the budget. Everything here is national property. The history of victories and defeats. So why is the Baykonur museum in a dilapidated building that formerly served as a barracks? Why has none of this been seen by our people?

In the end we will not be sanctimonious. You can make millions from visits to Baykonur. And not only in rubles. A long time ago Americans invited tourists to their launches. The principle: you pay, you see. And what's stopping us? After all, thirty to forty minutes away from Baykonur by plane is our tourist Mecca: the ancient cities of Central Asia. Any foreign tourist would gladly pay to be able to deviate a day or two from his itinerary to see the place where man made his first assault on the Universe.

In Alma-Ata we discussed this question for a long time with V. Kovalerov, the chairman of the Kazakh SSR bureau of international youth tourism, Sputnik: "We thought of that a long time ago. We could get started even if it were just by setting up excursions to Baykonur for school children. And it wouldn't be terribly expensive. But how do we approach it? It's a monopoly there. And everything's in the monopoly's hands."

The American space programs have had a very positive effect on the business life of the country. They have space technology for the production and preservation of products, plus various instruments, home computers—all of that and many, many other things have long become a permanent part of the daily lives of Americans. Our achievements have remained for naught. Why? This question was answered very well in an article in the

journal EKHO PLANETY by Pilot-Cosmonaut of the USSR, twice Hero of the Soviet Union G. M. Grechko:

"We don't know how to put our achievements to use. Moreover, technology has been unjustifiably kept secret, cutting off enterprises and departments from extensive access to it."

The same story is repeated on the local level. A year or two ago, passing near Leninsk, I saw an enormous scrap heap. The department had thrown out damaged or unneeded equipment, defective construction materials and equipment. Local craftsmen from surrounding collective and state farms went to it, took what they needed, extracted spare parts, metal, building materials. That's what the contact between the surrounding world and our space departments was like. The concentration of certain of the enormous intellectual forces of the society in one place has not affected the life of this region. The city and the cosmodrome have for too long been cut off from the world around them. And not only by the wall. In Leninsk, for example, there is a branch of the Moscow Aviation Institute. But it's virtually impossible for local residents to set foot in it. They need special orders, etc. The department has no desire to distribute even a portion of their requisitions to local enterprises—it says the level of technology and skills of the personnel are too low. No one argues with this. But you have to teach people and invest money into something like this. The city has not become today's producer of skilled workers for the region. And its existence does not stir any emotion among the local population, except irritation. So, there's apparently some merit to the speeches in the Congress of People's Deputies demanding the reduction of expenditures for space programs. To put it figuratively, who is going to feed a pig in a poke?

The time has come to re-examine many things. The conquest of space should become an open matter. Only then will it be a catalyst for technical progress in our society

What needs to be done? For a start, take down the wall. And the concrete. And that invisible sacredness that for so many years has surrounded this city next door to the cosmodrome.

Czech Correspondent Argues for Major Reforms in Intercosmos Organization

18660217 Moscow PRAVDA in Russian 5 Sep 89 p 4

[Article by Karel Patsner, science reviewer for the Prague newspaper MLADA FRONTA, under the rubric "A Word From the Foreign Press": "'Intercosmos' at the Crossroads: The Partners of the Soviet Scientists Have Long Grown Out of 'Short Pants'"; first paragraph is introductory paragraph in source.]

[Text] **For more than thirty years, I have studied the development of cosmonautics as a journalist. With the people who work in this field I have experienced all their joys and sorrows. During trips to the Soviet Union I have managed to become acquainted with many specialists and cosmonauts, and have remained friends with some of them for many years. In the US, I witnessed the first manned flight to the Moon.**

There is a fear that the Intercosmos program is now at a critical juncture, that it is at a cross-roads, and its fate hinges on a fundamental reexamination of the forms of cooperation. Many Czech scientists who have participated in Intercosmos matters have long experienced an uneasy feeling that the door to space is closing in front of them, and that they will be left behind. This is the same thing that distressed them a quarter century ago, before the program even existed.

It was then that the Soviet Union proposed to other socialist countries to adopt a program of multilateral cooperation, Intercosmos, for the peaceful investigation and use of space. I remember how happy my friends—astronomers and geophysicists alike—were to hear about this. After all, their Soviet and American colleagues and other scientists had been publishing research since the early 60s that was based on measurement data obtained from artificial satellites, interplanetary probes, and high-altitude research rockets. But our scientists were uneasy: if you can't obtain basic scientific data directly from space, it is impossible to avoid falling behind.

This is why the news from Moscow was received so warmly by Czech scientists, and the Intercosmos program fulfilled their hopes at the time.

However, now that the Soviet Union is becoming more open to the world, preference in cooperation on various projects is more frequently given to western partners, while the laboratories and observatories of the socialist countries are being moved to the, so to speak, "second string."

The Soviet proposal in 1965 was noble: you use for free our booster rockets, satellites, and any ground-based support for pre-flight, flight, and post-flight operations, but, they said, you provide ideas and instruments. The Soviet Union will bear practically 95 percent of all expenses. I don't think this was merely a political gesture, but a genuine wish to expand scientific and technical bases.

In the spring of 1967, work began which no one in Czechoslovakia had ever encountered before. One could rely only on the foreign literature, the promptings of Soviet colleagues, and unlimited enthusiasm. The initiator and first to go through all of this was astronomer Boris Valnichek, now a doctor of sciences and director of the Laboratory of Astrophysical Studies of the Astronomical Institute of the Czech Academy of Sciences in Ondrejov.

At the same time, doors began to open for our specialists in formerly secret Soviet laboratories and cosmodromes. On 14 October 1969 the Intercosmos-1 satellite was

launched from Kapustin Yar. Delegations of scientists from all of the socialist countries participated in the celebration.

The satellite functioned very well. It was the first collective success of the socialist countries in the investigation of space.

In all, more than 20 Intercosmos satellites were launched, and on only one was Czech astronomical or geophysical equipment absent. In 1978, our geophysicists, on their own—it is true, again with the needed Soviet help—built the Magion satellite, which was placed in a near-Earth orbit along with Intercosmos-18.

In the framework of the program, 11 high-altitude Vertikal research rockets were launched, and the Intershok geophysical project was carried out. Czech specialists, with their ideas, suggestions, and equipment were included in the Soviet national program: the launch of the Prognoz satellites and the Mars, Vega, and Fobos interplanetary probes...

A significant chapter in the Intercosmos program consisted of the flights of cosmonauts from socialist countries. Although they were motivated, in my opinion, by primarily political considerations, they also played their scientific role (at least in Czechoslovakia). They became for some scientific disciplines a pre-requisite for forming a new way of looking at some problems or a basis for promising research.

All of these facts and figures are wonderful. The Intercosmos program is really something to be proud of. At the same time, however, it must be noted that the results could have been better if everything had functioned as well as was suggested in international and intergovernment talks, namely, if all agreements had been absolutely binding for all parties. Intercosmos, after all, was only a program, and not (unfortunately!) an international organization with binding laws. Moreover, among many scientific representatives who directed the program in individual countries, the old idea survived that space research was a kind of luxury, with more political than practical significance.

Much changed, however, over the 20 years of existence of Intercosmos. At first, it involved only pure space research. However, for a number of years, cosmonautics has been of great service to work on Earth in various fields (communications, meteorology, navigation, the probing of Earth's resources, etc.). Recently, the production of superpure or absolutely new materials in zero gravity has been added. Moreover, if someone needs to begin space research for the first time, the first thing he immediately learns is that one cannot get by without high-quality production of unique equipment or equipment which is produced only in small quantities. And this equipment must withstand the extreme conditions of open space. Otherwise, one is forced to buy this equipment abroad at an exhorbitant price. So that before us now—and there are few who realize this—is a unique new scientific, industrial, and service complex.

Heading the individual national Intercosmos commissions are the highest representatives of the academies of sciences. At first it made sense to unite these functions, for such "science managers" used their own influence to probe the path of cosmonautics. However, now this work has grown so much that managing it in this manner is impossible.

The very concept of individual projects is based, for the most part, on the goals of Soviet cosmonautics. "But, of course, we are not equal partners," complains doctor Valinchek. Another problem is that the Soviet rocket-and-space industry is geared to the production of heavy satellites which are not accurate enough for scientific purposes, yield relatively little data, and are too large. This is why the researchers at the Geophysical Institute of the Czech Academy of Sciences are developing their own series of small satellites (modestly called "subsatellites").

When there are discussions of the pertinence of a given project in the Intercosmos program, some Soviet specialists forget that their foreign colleagues have already "outgrown their short pants." In other words, the Soviets are not always objective about foreign proposals. In the past, the Soviet teachers were accustomed to "testing" their own ideas and equipment; however, today some of these ideas have become obsolete, and the equipment is sometimes less productive than equipment produced in other countries.

They simply don't understand that in the last two decades, their foreign colleagues have already, for the most part, turned into equal partners. It may also be that the idea that "all that is Soviet is excellent" is at work here. This is an idea which quite recently was in circulation in all socialist countries (and expresses a way of thinking in Soviet science, which developed separately from the rest of the world).

However, even the implementation of a particular project does not necessarily mean that it benefits science. The majority of Soviet organizations insist that they will "fish out" the data transmitted from a satellite or station, and afterwards they will hand it over to the institute that developed the concept of the experiment or provided the on-board equipment. Unfortunately, foreign partners receive this data late. We're not talking about a delay of a few days or weeks—that would be OK. But the soonest it arrives is after 3-5 months. And sometimes it comes when it no longer has practical value, because the data has long been outdated by information from western spacecraft.

All of this is evidence that the Intercosmos program is a union which is too freewheeling to win in the future in a close competition with other organizations.

Unfortunately, this can also be said of the practice of recent years, when the Intercosmos cooperation became for Soviet specialists an incidental matter. After all, now they consult primarily with western partners on their ideas for large projects. Their real reason for this is that

western governments can propose on-board equipment based on the better electronics and advanced technology. And something else, it seems, affects Soviet scientists. It is much more attractive for them to travel on business to Paris, Munich, or Pasadena than to Prague or Warsaw.

Of course, before suggesting a different structure for Intercosmos one must begin to set up national organizations that are more goal-oriented.

First, a state Intercosmos committee should be formed, headed by a science-and-industry manager. The deputy minister could be the chairman of the state commission on science and technology and investment development, that is, a person who would fully devote himself to cosmonautics. The representatives of all the institutes, enterprises, and organizations involved in the given problem would be the members of the committee. Of course the committee should have its own budget, from which it would finance all projects carried out by its own production bases, as well as abroad.

It seems to me that a conceptual program is not enough for Czech cosmonautics. Its individual projects and participation in international programs, as a rule, are based on individual or political interests. In saying this, I don't want to offend many of my friends who have "ploughed" a vast field on this arable land. Rather, I want to direct attention to the fact that there is no one at the center who could keep track of all the directions and prospects and advise concentration of attention on projects which could be important and promising for us.

How should the Intercosmos international organization look now? I think we should take as an example the Joint Institute for Nuclear Studies and the European Space Agency.

At the head should be a steering committee consisting of representatives of participating states, and for on-going direction, a general director. Individual governments would make their contributions to the Intercosmos budget in accordance with a specific "key." Nothing would be for free, but nothing would be counted in dollars either. Proposals for projects would be discussed by the commission. Scientists from western countries could be members of the commission, which Doctor Petr Yakesh points out. He is a candidate of sciences, deputy director of the Central Geological Institute in Prague, and a geochemist who worked for a year and a half in Houston studying samples of lunar soil. "Only in this way," he states, "can we achieve a yield on the world scientific level from those projects that are being talked about in socialist countries."

If the Intercosmos-USSR state commission had its own scientific and technical base, it could in time become a partner, and in some areas, a competitor to the proposed USSR Space Agency. General V. Shatalov recently spoke out for the creation of this agency in IZVESTIYA.

The new political thinking which the Soviet Union and other governments are advancing in diplomatic, military, and trade matters should have been more rapidly introduced to the approaches to scientific cooperation among European countries of the east and west.

Notes on Career of Designer V. P. Glushko

907Q0016 Moscow KRASNAYA ZVEZDA in Russian 26 Aug 89 p4

[Article by Col M. Rebrov; sidebar in boldface]

[Text] With this article, we end our series on about those who designed our early rocket and space technology: The designers and scientists who were members of the famous "Council of General Designers."

Inevitability of the Future

The Energiya rocket was fired in the experimental test stand. The days of preparation had passed nervously—one thing or another was always causing problems. The engineering management calmed everybody down—of course it was going to be that way, even though it was only the first firing, and the system was extremely complex. Glushko casually remarked, "No stopping at flag stops." Work continued. The most powerful launch vehicle in the world—20 Krasnoyarsk hydroelectric power stations harnessed together in a single unit—was launched from Baykonur on 15 May 1987. The colossus left the launch pad smoothly and gracefully and began to gain altitude. The announcer counted the seconds into the flight and reported on the behavior of the "product." The engines started to climb.

A "product"... It's quite one thing to look at this beautiful embodiment of power from outside, and quite another when all of this has been won by suffering through the long years along the difficult path from the idea to the final product, through the rough plans, through the heated arguments, the design changes, the working documentation, assembly in the shops, and the testing at the assembly and test hangar.

The general designer of the Energiya—Buran rocket and the space transportation system (consisting of manned spacecraft and space stations) felt a heart spasm during the final session of the state review board, but forced himself not to notice the pressure on his heart. It had come twice before, and "gone away" each time. In the plane on the return trip to Moscow, he tried to recall when it had first happened. October 1957 floated to the surface of his memory.

...Night had descended on the cold steppe like the pitch-dark inside of a tent. One of the searchlights went out, and the ghostly yellow image disappeared. The rocket, surrounded by a network of farms, seemed taller and more well-proportioned. White jets from evaporating oxygen silvered the metal of the secondary stages to each side, as well as the main rocket. "Beautiful," thought Glushko, "very beautiful."

It was quiet. Amazingly quiet. Low clouds swirled about and amplified the dance of the imagination: "Beautiful and impressive!" Glushko glanced at his watch, and thought, "They'll be done filling the oxidant soon."...

The silence of the night was broken by individual voices which carried from the loudspeakers at the launching pad. He remembered hearing: "One hour to launch!"

Time seemed to accelerate up to the minute that humanity had been waiting for for centuries. And then a sharp pain stabbed his heart. He held his breath, decided not to stir. The pain did not diminish. His hand slipped into his pocket for his menthol valerate, but didn't find it. "Probably left it on the table," he thought momentarily.

Sweat broke out on his forehead, and the pain appeared to vanish. "The launch command should be coming soon," he thought as he attempted to distract himself. At this very moment, a bright vortex of flame appeared at the base of the rocket.

The next day, an excited planet tried to understand the lines of the very first TASS communique about a space mission:

"With this, the first launch of an Earth satellite of human origin, an enormous contribution has been made to world science and culture. This high-altitude scientific experiment carried out at this high altitude is of enormous importance from the point of view of understanding the properties of space and in studying the Earth as a planet in the solar system. Artificial Earth satellites will lay the groundwork for interplanetary space travel..."

The second time it happened was in the assembly and test hangar when he was sitting in the pilot's seat of the Vostok spacecraft. The spacecraft had just been attached to the rocket, and they were getting ready to attach the nose cone. Glushko became agitated at the realization of what was going to happen: "Tomorrow, this will all be taken out to the pad and..." His joy at the thought that this was literally going to happen "tomorrow" was clouded by a sudden sick feeling that crept up on him. He remembered the lines from the letter by K. E. Tsiolkovskiy: "Long and difficult is the path to the stars..."

When Gagarin's smiling face appeared at the window, everything passed.

"You can have your seat now, Yuriy Alekseevich," Valentin Petrovich said as he hurried to leave the spacecraft.

...Glushko was prevented from attending the second launch of the Energiya rocket by serious illness.

He took the fact that the doctors had forbidden him from attending the launch and the fact that he was bedridden very hard. He was tormented by doubts: "How will they do without me there?" He envied his colleagues, and frequently returned to the past in his mind. Sometimes it seemed somehow improbable. But it was true.

The Blue Haze of a Dream

The thin, precisely dressed, well-built young man stopped in front of a door with a small handwritten sign: "Plenipotentiary Representative of the Military Committee for Scientific Research, Revolutionary Military Council of Leningrad and Leningrad Oblast." He stood before deciding to knock, took a deep breath, and pulled the door handle.

Behind a desk buried in paper sat a pince-nez-wearing man of about forty in a green soldier's shirt with a shoulder belt and a diamond on each of his red collar tabs. He raised his head and glanced with his weak eyes at the person who had just walked in.

"I am Glushko," the young man introduced himself, showing the notification he had received the day before.

"Come in, come in, be braver," Nikolay Yakovlevich Ilin leaned over the desk and extended his hand. "I was the one who invited you. Sit down, tell me about yourself..."

The young man was embarrassed: What could he say? He was born in Odessa in 1908; his father was Ukrainian, his mother a Russian nurse. He had graduated from the city trade school in 1924, where he had learned the basics of plumbing and lathe work in addition to his general studies; he liked to draw, and was interested in music, but took a fancy to the exact sciences, had graduated from Leningrad University, and had submitted a plan for an electrothermal rocket engine to the review board on 18 April 1929... And that was it.

Ilin looked intently at the former student. "The kid's got a good head," he thought to himself, "a person of few words, but he speaks enthusiastically and logically, and his plan is sensible." Aloud he said: "And why, all of a sudden, a rocket engine and not an airplane engine, or an engine for a dirigible, for example?"

Glushko shrugged his shoulders and said, "Tsiolkovskiy, Goddard, and Obert are developing rockets. An electric current can detonate thermal explosions that will accelerate a rocket in airless space. I've done the calculations..."

"Professor Shuleykin of the Communications Department of the Workers' and Peasants' Red Army and Tikhomirov, head of the gas dynamics laboratory, have been acquainted with your calculations. They are interested in your idea. What we need now is some experiments. What would you need to do this?," asked Ilin.

"To begin with, electric power and a place to work."

Ilin became thoughtful, but soon concluded brightly, "That won't be too difficult. I believe that Abram Fedorovich Ioffe will be glad to assist you. He's head of

the Institute for Applied Physics, involved in the construction of extensive facilities, and has a laboratory called "Million Volts." Will two million volts be enough for you?"

"That will be enough," Glushko answered earnestly.

"Very well," the plenipotentiary representative of the Military Committee for Scientific Research summed up their discussions. I'll call Professor Ioffe, and also ask Nikolai Ivanovich Tikhomirov to assist you in setting up the experiment.

Il'in did not know then that he would become head of the Gas Dynamics Laboratory, that the young and capable engineer Glushko would be working under him. As, by the way, he also did not know that it was the ancient dream of space flight that had crept into the young boy's heart after reading Jules Verne's novel "To the Moon and Back," the fascinating little books by Perelman, and the "discoveries" of K. E. Tsiolkovskiy, who lived in faraway provincial Kaluga, who was an insistent advocate of human space exploration.

Glushko was fifteen when he took the risk of sending Tsiolkovskiy a letter. Somehow naive, but sincere and written with conviction, the letter touched Konstantin Eduardovich. In October 1923, a postman brought a home-made envelope with a Kaluga postmark to 10 Olgievskaya Ulitsa in Odessa. It was a reply for the sixteen-year-old student and scholar. Tsiolkovskiy thanked him for his letter, and inquired as to how seriously the young boy was interested in the problems of space travel. The following day, the same postman also brought a small package containing books. A second excited letter soon left Odessa for Kaluga:

"As far as my interest in interplanetary travel is concerned, all I can say is that this is my ideal and my life's goal—I want to devote my life to this great cause..."

The years pass, and Glushko, now an academician, says:

"You ask: What is the main trait of a person devoted to science? There are several: Being in love with one's chosen field of knowledge, having a desire to give it and it alone undivided attention, and an ability to abandon in time anything that might lead one astray..."

However, back to business... His interest in space and rocketry began with explosives. There were artillery dumps in Odessa during the civil war. The retreating White Guards had blown them up, but some unexploded shells still remained under the ruins. Valentin went to these places fairly often with his friends. Any shells found were carefully disarmed and the fuses and trinitrotoluene used for experiments. The father, fearing that these "experiments" might end badly, put an end to the dangerous pastime.

And the dream? It lived on and continued to call him, exciting the imagination. Tsiolkovskiy was far away, so Glushko sought out like-minded people in his native city. Fate threw him together with Aleksandr Ivanovich Stefanovskiy, who was head of the Naval Museum and had gathered around himself a group of young people who dreamed about the outer space, were interested in design, and were seeking their paths in life.

The young boy disappeared into the museum in the evening and on his days off, drew a color map of Mars and a sketch of a spacecraft for an exhibit at the museum. He was then drawn to the astronomical observatory for meetings held by the members of the Odessa division of ROLM (as the Russian Society of Amateur Cosmogonists was abbreviated). Lectures, seminars, independent observations of planets, and calculations of their trajectories.

An article with the rather strange title "4 July 1924: Conquest of the Moon by the Earth" appeared on 18 May 1924 in IZVESTIYA ODESSKOGO GUBKOMA KP(b)U. The article contained closely reasoned arguments showing that it is only possible to carry out space travel using the reaction engines proposed by Tsiolkovskiy. In January 1925, the journal MIROVEDENIE published his sketches of the planet Venus, and within a year, Glushko had published another article entitled "Extraterrestrial Stations" in the journal NAUKA I TEKHNIKA.

BREAKTHROUGH

The Leningrad Gas Dynamics Laboratory... This is where, in 1929—1930, it was theoeretically and experimentally shown to be possible to construct an electric rocket engine. Solid and liquid current-conducting materials (aluminum, nickel, tungsten, mercury, etc.) were used as working substances. The thrust was created using electrical explosions. Quite small then, but electric rockets were eventually used thirty years later in the thruster units on the Voskhod and Zond-2 spacecraft.

And then, in the early 1930's?

The test stands and workshops of the Gas Dynamics laboratory were located in the St. John raveline on the grounds of the St. Peter and Paul Fortress. They happened to start testing of the "rocket motor" precisely at noon, when the cannon was shot off from the Naryshkin bastion.

Glushko first began to work with liquid-fuel rocket engines during those years. The first engines, designated by the abbreviation ORM (experimental rocket engine) appeared: the ORM-1 and the ORM-2. They used electrical ignition systems, expendable nozzles, and a variety of liquid fuels.

A large number of experimental units (from the ORM-4 to the ORM-22) were successfully tested in 1932. Over the next year, new engines were developed on the stands, from the ORM-22 to the ORM-56. The latter engine, with a thrust of 300 kgf, successfully went passed the official static tests and was recognized as the most powerful rocket engine of that time. It was designed for sea torpedoes, airplanes, and the RLA series of rockets.

It was also planned to mount two such engines on the wing flaps of A. N. Tupolev's I-4 fighter.

The RLA-100 project—the construction of a rocket for vertical flight to 100 km altitude—also dates to the early 1930's. Mass at launch 400 kg, engine thrust 300 kgf, payload mass 20 kg. After attending the static tests at the Gas Dynamics Laboratory, M. N. Tukhachevskiy became interested in further ideas from the designer. In a memorandum to the government, he wrote:

"The Leningrad Gas Dynamics Laboratory under Technical Headquarters (Glushko was head of Sector II—-liquid-fueled rockets—M. R.), which is working on problems associated with reaction engines and their use in various types of military hardware, has now achieved significant and important results. These results have occurred in scientific research work and theoretical work carried out at the Gas Dynamics Laboratory, as well as in carrying out practical testing and experiments withvarious types of rocket missiles and devices, as well as in the selection of valuable workers and engine researchers... The use of this engine in artillery and chemistry creates unlimited opportunities for firing shells of any size with any range. The use of reaction engines in aviation will eventually lead to the solution of the problem of high-velocity stratospheric flight."

On 21 September 1933, Tukhachevskiy issued an order from the USSR Revolutionary Military Council concerning the organization of the Workers' and Peasants' Red Army Scientific Research Institute for Reaction Engines on the basis of the Leningrad and Moscow organizations to work on problems related to rocket design.

Black and White Pictures From the Past

What else could you call what happened on 13 February 1938? On this date, an expanded meeting of the Scientific and Technical Council of the Scientific Research Institute for Reaction Engines was held. On the agenda was the denigration of the personality of engineer V. P. Glushko. He was charged with having connections with "enemies of the people," the disclosure of military secrets, and avoidance of public work. Among those who "unmasked" him were I. T. Kleymenov and G. E. Langemak, leading staff members of the institute, who had been arrested by the organs of the NKVD (People's Comissariat for Internal Affairs).

They were not able to fit it all into a single day, and a final decision on Glushko's "case" was postponed to the next meeting. It was all repeated on 20 February. Literally competing with one another to be politically uncompromising, vigilant, and alert, Glushko's colleagues raised their hands and deprived him of the right to defend himself. Only one person stood up for him. But the M. A. Petrov's lone voice was, of course, not heeded. The attendees unanimously adopted (with one abstention) a resolution stating that V. P. Glushko was "unreliable." A few days later, he was arrested.

Several rather curious documents dating from those dark years have been preserved in the archived investigation file for Glushko's case. Among those is a statement to the party committee of the Scientific Research Institute for Reaction Engines naming Valentin Petrovich along with several others as "wreckers." This denunciation had been written at the end of 1937, and quickly found its way to the NKVD.

S. P. Korolev, who had publicly stated that he could not believe that Glushko had intentionally engaged in wrecking activities in the course of his work on various important military topics, also found himself in an investigative isolator several days later. The denunciation stated that they were both "responsible for all errors, omissions, mistakes, and disruptions at the test stands" that had occurred while the new technology was under development.

The details of the events which took place during those terrible years (and their reasons) have still not been completely revealed, but...

By comparing the stories of Professor Yuriy Aleksandrovich Pobedonostsev (one of the early pioneers in rocket research), the testimony of Lieutenant General (Justice) Boris Alekseevich Viktorov (former deputy chief military procurator), and the recollections of Valentin Petrovich Glushko himself, we can recreate the events leading to the persecution of these two prominent designers.

...The Scientific Research Institute for Reaction Engines, which had been created from the Group for Research on Reaction Engines and the gas Dynamics Laboratory, gathered strength. Marshal Tukhachevskiy provided support and assistance to the group. In 1937, Kleymenov, director of the institute, carried out a structural reorganization in the interest of completing the most important items in the research plan as quickly as possible. V. Glushko, V. Tikhonravov, and several other engineers were working on the development of liquid-fuel rocket engines. One of these groups was headed by A. G. Kostikov, who arrived at the Scientific Research Institute for Reaction Engines immediately upon his graduation from the Academy imeni N. E. Zhukovskiy.

Glushko soon became the leader of one of these independent groups, while Tikhonravov was transferred to other work. He and Glushko, together with Korolev, were involved in work under three items in the plan, designated by the numbers 318 (a rocket fighter-interceptor), 312 (a winged missile with a range of 50 km), and 301 (an air-to-air guided missile).

Kostikov quite soon turned up in the director's chair of the Scientific Research Institute for Reaction Engines. This was, by the way, a special (although quite dismal) page in the history of rocket design in this country. I shall merely note that Kostikov led the meeting of technical experts on 20 June 1938 which had prepared the "evidence" of wrecking activity on the part of Scientific Res3earch Institute for Reaction Engines staff.

The Gordian Knot of Fate

What then? Valentin Petrovich did not like to remember his years of "imprisonment." In talking with reporters about his life, he spoke briefly, in a restrained manner:

"The staff in our department working on engines became an independent organization in 1939—1940. But the Great Patriotic War began, and our office was already an experienced design bureau for the development of reaction engines by the first year of the war (Note: It was behind barbed wire, under special regime—M. P.). I was named head designer, and Professors G. S. Zhiritskiy, K. I. Strakhovich, A. I. Gavrilov, V. V. Pazukhin, engineers D. D. Sevruk, V. A. Vitka, N. N. Artamonov, and other talented specialists worked with me at various times. We proposed that reaction engines be used to improve the fighting capabilities of airplanes.

In 1940, Glushko's group was moved to an aircraft factory in Kazan. The plan developed before the war for a liquid-fueled reaction engine was adopted by the Air Force. Static tests were begun. Twenty-five of the firings were successful, and one resulted in forty minutes of continuous operation. In 1942, Korolev was transferred to Kazan and appointed Glushko's deputy for flight testing.

The meeting made them both happy. Each had a good idea of the project before them, saw ways to solve it, knew a great deal, and were extremely capable. Together, they could accomplish more, and did not spare any effort to this end. Korolev himself took part in the flight testing, got in a crash, and went once again into the skies after he had barely recovered. During the war years, they worked on the development of auxiliary liquid-fueled reaction engines for acceleration during maneuvers by military aircraft. These engines had controllable thrust, the nitrogen—oxygen—kerosene fuel was pump-fed, they were chemically ignited, and the number of successive completely automated firings was limited only by the operating lifetime.

October 1943. The Pe-2 bomber, equipped with one of the auxiliary engine assemblies, made a flight on the first day of the month. The flight was a success. The engine was only in opeartion for two minutes, but provided a velocity increase of nearly one hundred kilometers per second. A second test involved accelerated takeoff. The auxiliary engine assembly enabled the length of the takeoff roll to be decreased.

Reaction engines were later installed on the La-7R, La-120R, Yak-3, Su-6, and Su-7 airplanes designed by S. Lavochkin, A. Yakovlev, and P. Sukhoy. A government test certificate and a report indicating that the RD-1 and RD-2 engines were usable were drawn up. Both of these documents were approved by Stalin, although he did not show any special interest in reaction engines.

Fighting the Pull of Gravity

Since 1945, Glushko's department of the design bureau has specialized in the design of powerful liquid-fueled reaction engines. The first such engines were the RD-100, RD-101, and RD-103, which operated on a mixture of oxygen and alcohol. The experience gained by the designers in designing this family of liquid-fuel reaction engines and using them in airplanes served as the basis for the development of more powerful engines for various purposes.

"Powerful engines," said Valentin Petrovich, "are the basis of everything. However, the underlying principle of both the foreign and domestic designs of that time did not enable us to increase the thrust of the engine or (especially) its specific impulse. These characteristics, which are so important in rocket technology, can only be improved by increasing the temperature and pressure of the gas in the engine chamber. But how could this be acheived? We found ourselves in a vicious circle, and the only way out was to seek a new design principle to be used in the engine chamber..."

Such a principle was discovered. An incredibly light, open chamber which could withstand high temperatures and pressures was developed. A way had been found to use highly efficient fuels in the engines.

Between 1954 and 1957, the RD-107 and RD-108 four-chamber engines were developed in this department of the design bureau for the first and second stages of an intercontinental ballistic missile, which later served as the basis for the Vostok launch vehicle. The multiple chambers enabled the length of the engine to be decreased and the weight of the rocket to be reduced. The engines had thrusts of 102 and 96 metric tons and specific impulses of 314 and 315 seconds, respectively. Reliable, easy-to-adjust, and fed by a single turbopump, these "little engines" were mounted on the vehicles that placed the first artificial satellites of the Earth, Sun, and Moon, and the Vostok, Voskhod, and Soyuz spacecraft into orbit, and carried out the first interplanetary flights to Venus and Mars.

This was a breakthrough into the unknown. The originality of the engineering solutions, the selection of materials, and the fact that pressures of several hundred atmospheres were achieved in the chambers, enabled the designers from this depertment of the design bureau (and Gas Dynamics Laboratory) to design a series of new high-thrust engines with a corresponding reduction in size. This series was crowned by the RD-170 engine, the standardized first-stage engine for rocket launch vehicles, including the Energiya rocket. These engines were constructed according to a highly economical closed scheme in which the gas processed in the turbine is reheated in the main combustion chamber. The RD-170 has record-breaking thrust and specific impulse characteristics, which led to the following summary of the results from the in-flight testing of the Energiya rocket: "The designers have been able to successfully attain high

specifications with minimal gas-dynamic losses, regenerative cooling, and stability of the materials used.

"What was the most difficult problem?" Valentin Petrovich did not delay in answering, "Sometimes it seemed as though our work consisted entirely of problems. Or more precisely, overcoming the problems. But, if you like, the most difficult problem was eliminating the high-frequency pressure oscillations in the engine. They did not cause any problems with low-thrust engines, but became threatening and destructive when engines whose power could be measured in the millions of kilowatts were tested. These tricky oscillations were frequently a real scourge, and absorbed the lion's share of the time and money..."

He evaluated the situation sober-mindedly:

"Don't think that creating the prototype is the most difficult thing. The second part of the problem—setting up creative contacts between the factories and the manufacturers and between the factories and the customers is often more difficult and sometimes even much more difficult...

He frequently recalled Leningrad, the Fortress of St. Peter and St. Paul, the gun at noon from the Naryshkin Bastion... Valentin Petrovich was quite zealous about history, could not tolerate any inaccuracy (even with respect to trivial details), and always had a document to back up every fact.

In writing our biography of the designer whose name has become a part of the history of military and civilian rocket design, we are not interested merely in dates, events, or a listing of what has been achieved and accomplished. We would like to know: What kind of people were these who were able to accomplish so much? What kind of people were these who realized their historic chance and were the first to launch Satellite No. 1, continued on to the Moon, and took humanity into space...

"A designer's blueprint or even a sketch...," he cast a glance at the window and became thoughtful. And then continued, "...isn't a design for a project, it's the outline of an idea, a fantasy, a dream... It never existed before, and perhaps will soon vanish, but is purely a creature of the mind... These sheets of paper and pictures were the future of space travel."

Another pause. Long and dreamlike.

"We dreamed of space, burst into space, but this wasn't an end in itself. The construction of a liquid-fueled rocket engine stimulated developments in a variety of scientific and technical fields. Studying and controlling the complex processes occurring in these engines led to numerous theoretical and experimental results in pure and applied science."

These are Glushko's own words, backed up by a wide range of interests and a serious attitude to the work at hand. He was able to be true to his dream. His inquisitive mind was working on the problems of flight to Mars: How to transport a crew there, how to make the flight safe, how to return the people to the Earth—all of this was in Valentin Petrovich's field of view. But Korolev was also thinking about this.

The Logic of Paradoxes

Lieutenant General Georgiy Aleksandrovich Tyulin, who was well acquainted with all of the members of the Council of General Designers, once called Korolev and Glushko's attitude towards the past "strange," but declined to clarify his statement, although he did tell the following story at that point:

"In 1957, Glushko and Korolev wrote a letter to the editor of the BOLSHAYA SOVETSKAYA ENTSIKLOPEDIYA concerning Kostikov and the fact that there was some doubt concerning whether he was in fact the designer who had developed several designs, as well as the fate of Langemak's... In short, about honor and lack of honor. They were not defensive, but wanted (and demanded) justice. However, Valentin Petrovich was the initiator of the letter. Korolev had convinced himself that one should forget Kolyma, prison, and all the rest, blot it out from the memory and from the heart. Glushko always remembered everyone and everything. He had saved many interesting documents...

"They breathed more easily, even after a run of failures during testing, once Beriya had been removed. What we don't know, though, is what kind of scars remain on the soul of a designer who tried to pretend that absolutely nothing happened, that he wasn't broken, and that he was prepared to continue what had been begun. Such people firmly believe that they need imagination, the right to take risks, to make experiments, and sufficient time to 'design the rocket in their heads.'

"Outward behavior was for appearances only. Personal life was anonymous. Like any intimate sphere of life, it is, fortunately, inviolable. But this is also unfortunate: Evil thingsare sometimes done under this cloak of 'intimacy.' Talent does not lead to isolation, but is subject to truth—the humblest truth as well as the greatest. It seems to me that the creative person is continuously shuttling back and forth between himself and other people. They are also not generally characterized by a sense of contempt for others. After all, they are called upon to understand rather than clash with one another. This is, by the way, a basic philosophy of life.

"Let me jump ahead a bit: I have a high opinion of such creative people, am absolutely confident of their loyalty to the Motherland, of their ideological commitment, if you will. And I am absolutely confident of both individuals, as I have had occasion to write at various times with pleasure and firm conviction. I recall this in order to support my right to speak to their differences. And there were differences. And here's the curious thing. Their paths crossed in the early 1930's—they respected

each other's talent for engineering, valued each other's ability to think and act, worked together fruitfully on numerous occasions (sometimes dreaming about the future of space travel), debated, called each other by their first names, and were on generally familiar terms. Until suddenly there was a clash.

"When the conflict is stripped of all the details, particulars, andattendant circumstances (which, however sad it may be, are almost always present in such circumstances), the two Chief Designers disagreed on their 'priorities.'

"It began with little things. One said that the most important thing in rocket design was the engine. 'Even a stick will fly if you tie an engine to it.' Korolev did not agree, and said that a rocket 'is only good as a unit.'

"Of course, this explanation is purely hypothetical. I admit that they might not have used the exact words used above, but at some point, the differences between the two Chief Designers became much more serious. Korolev needed a powerful launch vehicle: he 'saw' it, lived for it, and made plans for a manned flight to the Moon. Glushko was not prepared to fulfill the order for the 'SP.' It wasn't what he wanted, and he tried to defend his position. The arguments were already about whether there would be a 'Soviet Saturn,' and if so, what kind. I won't judge who was right and who was wrong. Things are more complex than they seem here. And it was not by accident that many believed that the N-1 rocket had no future in space even then, although it did have many backers.

In any event, the disagreement between the two talented designers was not a personal affair; otherwise, there would be no need to resurrect the past. I mention this case because it disappointed many people who had spent time working on the N-1 and had had high hopes for the project. These people had signed on with a very promising Moon rocket. But deceived hopes are a most dangerous thing, worse than a failure in testing, because it disappoints some people utterly and incites rage in others. However, the experience gained from this project (which was fairly substantial) should not go unrecognized."

In Pursuit of a Chance

Late autumn, 1988. Many asked themselves with heartfelt anxiety and grief how long he could continue to torture himself. He walked along the corridor with a mechanical gait, shaking slightly, almost losing control over his motions, clutching at door handles, sliding from one wall to another—bent strangely, with a face as white as a sheet and an immovable stare.

Yes, he refused to acknowledge defeat before the worsening illness as long as he was still breathing. He hoped that the illness would pass, and stubbornly continued to call in to work and demand progress reports on the Energiya rocket and the Buran spacecraft.

It should be mentioned at this point that none of the six original Chief Designers attempted to be the "living image" of our rocket and space program to the extent that Valentin Petrovich Glushko did. His fame, which was comparable to that of Korolev, was based not only on talent but also on the myth that grew to surround his name and was then carried around the world. According to this myth, he was cut from the same cloth as those gifted people who "mold" their lives artistically, making it into a form of art. This mythical Glushko was a non-aging, sports-loving man, enchanted by space, who had created a series of unsurpassed designs for rocket engines and was the originator of entire fields of research. In a word, a person endowed with all the symbols of fame and success.

However, the word "myth" is not quite accurate. He was indeed a person of his time—enchanted by technology and progress, burning with impatience to use all of the new tools which the achievements of science and the development of industry placed at his disposal. Glushko's career as a designer was marked by the desire and aspiration to be the first. He was always able to turn up where no one expected him, occupy all of the commanding positions simultaneously, and turn temporary retreats and even defeats into convincing final victories...

He was well received by Khrushchev and Brezhnev and had Ustinov's support, which helped him implement many of his ideas. In 1974 (at that time, the Experimental Design Bureau imeni S. P. Korolev was headed by his comrade-in-arms Academician V. P. Mishin), Glushko "agreed" to become head of the famous institution after a visit somewhere "at the very top." However, Glushko's many years' work at the OKB imeni S. P. Korolev, which became a hallmark of his ability as an administrator, his persistence, and his flexibility of thought, did not weaken the memory of his predecessor. The "SP" carried the day in the comparison between past and present.

Nothing, it seemed, could quench his thirst for activity, his frenzied passion to go down in history by completing what would come to be called "the first in the world." He was compared to the director of an enormous orchestra who was enchanted by the dream of playing something in such a way that would make the world talk about "the new Russian triumph in space." And, to a certain extent, he succeeded in this: The dreamer was also a realist, just as K. E. Tsiolkovskiy, who predicted longer time spans for the realization of his most daring ideas, was in his day.

What explains this? A striving for fame? Possibly. Ambition? Undoubtedly. But high-flying ambition. It, ambition, always called him further, higher. In the final analysis, his life and deeds reflect the times, with all of their contradictions, changing faces, stagnation, and upward flight. The following words, said in a melancholy

vein, are his: "How unfortunate it is that you can't live twice, that you can't reach your goal faster, without the mistakes!"

His evolution as a designer confirms what we said above: He was never weak nor banal—traits that frequently accompany material and professional success. As he himself said, his life was a long, difficult search which essentially consisted of attempting to reach the desired level of simplicity upon mastering incredibly complex designs.

He apparently gave himself over fully to his main life's work, and was ready to sacrifice for it. But that was only the way things seemed. Where Korolev could, at some point, after judiciously evaluating his capabilities and reserving the main strategic problem for himself, turn some problems over to his students, Glushko did not let anything out of his hands.

But death eventually catches up with us all...

He died in January 1989.

[sidebar]

"Specific impulse is the ratio of the thrust of a rocket engine to the expenditure of mass per second." In other words, it is the derivative of the impulse with respect to mass expenditure on a given time interval. As stated in all technical handbooks on space travel, this is the most important characteristic of a rocket engine.

And what is the specific impulse of a designer? How do we define it? Is it appropriate to make such a comparison? I don't know, but I'd venture to say that something of the sort might apply to the style and diligence of a designer.

The number of them among us is growing smaller and smaller, which makes us all the more eager to scrutinize their biographies and hear their own words about how it all began and how it was then... They are, after all, the ones who were in charge of our early exploration of space.

[end sidebar]

Semenov Describes Next Missions for 'Buran', 'Energiya'

LD1611133889 Moscow Domestic Service in Russian 1600 GMT 15 Nov 89

[Excerpts] Today is the first anniversary of the launch of the universal space transport system 'Energiya-Buran.' Our correspondent Leonid Lazarevich, who conducted live reports from Baykonur a year ago, has interviewed general designer Yuriy Pavlovich Semenov at the Energiya scientific production association: [passage omitted]

[Begin recording] [Semenov] I must say that, of course, the success was immense. It enabled us to review our program for the use of 'Buran.' Whereas previously we had planned the second flight as a simple flight with a slight expansion of some operations in orbit, today we have reviewed that part as well, and we are planning to conduct the second flight according to a complex program. This means serious transfers between orbits, with a flight duration of up to 7 days. We have started putting the final touches to an automatic system for approaching and docking with the 'Mir' station, work on an onboard manipulator, the simulation of rescue conditions, the docking-on of the Soyuz craft, and the transfer of a crew from the 'Soyuz' craft to the 'Buran' craft.

[Lazarevich] All in one flight?

[Semenov] Yes, all in one flight. Therefore, of course, it is a very full and complex program. Naturally, it requires a very complex approach. It will need time. Therefore, as we have announced, the next launch will be performed in the first half of 1991 with a more complex program. Today the craft is in the testing area. We shall start electrical tests on it in the first quarter, in order to keep to the agreed schedule.

[Lazarevich] But will the testers have to wait in the meantime? I can remember that they had such expectations and hopes.

[Semenov] We are planning that the next flight after that will be in 1992. It will be a manned flight.

[Lazarevich] What about the second half of the system—I mean 'Energiya.' Nobody in the world possesses such a giant, such a powerful rocket; but there is an impressions that we do not yet have anything to put into orbit apart from 'Buran.'

[Semenov] We submitted an initiative at the end of last year. That initiative was supported. Today we are developing a standardized space platform and a booster unit for 'Energiya.' That whole range of equipment will enable us to have a mass of up to 18 tonnes in geostationary orbit.

[Lazarevich] There are small satellites operating in orbit now. Will the platform be more favorable?

[Semenov] It is a qualitatively new leap in providing the country with a telephone network, the creation of a [word indistinct] television system in the information sphere. It is a qualitatively new leap, quite apart from the fact that it wil be a diverse, special complex. We can also resolve here the issue of resources which we will require for some 10 years. As a whole, it is a very economical system, meaning that it will not require tens of hundreds of launches of small satellites, which are also very expensive in the final analysis. For this it will be necessary to have around four platforms to solve the problems which we have today in providing a telephone network and a television network. [end recording]

Space Research Must Be 'Kept on Course'

PM2211112289 Moscow PRAVDA in Russian 15 Nov 89 Second Edition p 3

[Special correspondent A. Pokrovskiy report on International Astronautical Federation Congress in Malaga: "Where Are We Flying To? Space Science and Practical Cosmonautics"]

[Text] Malaga, Moscow—Polite applause marked the end of "Soviet day" at the Malaga congress, and at the same time the end of the congress itself, the 40th in the lifetime of the International Astronautical Federation. Round numbers prompt summings-up, and the slogan chosen for the congress was "The Next 40 Years in Space."

But the experts who gathered in Spain proved reluctant to make predictions. The Soviet delegation, on "its" day, confined itself entirely to reports on faits accomplis—"Energiya" and "Buran." I remember how at the same congress in Brighton 2 years ago, the first reports on them prompted a torrent of questions in the packed auditorium. This time, the spent energy of technical details created no more than a measured hum in the spacious premises. The thought processes apparently did not generate enough heat to illuminate even the immediate future in the highways of space, not even the future work of "Buran" itself. Indeed, perhaps it is no accident that "Buran" has been resting for a year after its single flight, or perhaps waiting to be given tasks appropriate to its fabulous powers.

What, in fact, is happening to our cosmonautics? Has it been knocked off course by the wave of criticism, which is particularly keenly felt after the accustomed eulogies? Or are PRAVDA's readers, whose letters were received on the eve of the congress, justified in their concern: "The view that we need to reduce spending on space is fairly widespread. It is fundamentally wrong! It is not sensible, not statesmanlike! You cannot ruin what is probably one of the few areas of science and technology today to have achieved world standards and even to be in the lead in many respects" (V. Nekhayev from Mogilev).

The question is formulated even more sharply by V. Beregoy from Moldavia: "Cosmonautics is probably the only sector that we can still be proud of today. For the time being.... But tomorrow? Tomorrow, perhaps, we will be lagging behind entirely. As long as the history of 'catching up' does not repeat itself.... I am willing to sacrifice my own resources, only do not ruin cosmonautics."

It appears that passions over resources have subsided somewhat recently. It has become clear that cosmonautics does not take so very much from society as appeared from the outside, but that it gives society more and more every year. All the same, let us suppose for a moment that it was given uncounted billions. What program beneficial to the prosperity of human civilization could the ideologists of modern cosmonautics offer for that money? I am afraid the question is purely rhetorical.

This is why. PRAVDA has written before about the uninspired nature of the outlines of our space program through the year 2005. I understand how this could wound the self-esteem of highly respected scientists. They did take offense. But the esteemed scientific institutions, among them the Institute of Space Research, which was directly mentioned in the column "It's Science Fiction," were unable to shrug off the injury by reporting promising developments.

Yet Academician R. Sagdeyev, ex-director of the Institute of Space Research, stated publicly: "When I ran for people's deputy from the Academy of Sciences, I included the following item on my election program: 'To restore the Soviet people's trust in the space program.' And I believe this must be done through glasnost, through truthful information, without empty show."

I found the key to this strange situation after my return from the congress, in an interview with another academician—V. Mishin. The chief designer, also now "ex," states: "First of all it is necessary to know and to have a long-term scientific program for space research. Unfortunately, what we have is a handful of disparate instructions pursuing political or prestige goals."

No, it was clearly no accident that as we returned to our hotel from the Malaga Palace of Congresses on that not very triumphant "Soviet" day, several members of the delegation and I recalled the times when there used to be two code names—Chief Designer and Chief Theorist. Now we know their real names. I think our respect for the services to world science and technology of that brilliant engineer and organizer Sergey Pavlovich Korolev will only increase when we consider that alongside him for many years was that profound theorist, Mstislav Vsevolodovich Keldysh.

At the same time I cannot help feeling that in "space circles" that name is increasingly receding into the shadows. The idea of the "autonomy" of space technology is simultaneously becoming more and more firmly established.

In crude terms, you could put it like this: Diverse and, frankly, talented collectives of "fixers," operating on the basis of their own tasks and ideas about priorities, create the latest "products," as they call them. Then they go to the scientists: Think about it, see what you can do with them.

Is not that what happened with "Buran"? They performed miracles of technical invention, organization, and targeted planning, but then they discovered that at the moment there is nothing weighing tens of tons to be shipped from space, and that anyway the scientists would have preferred to make do with cheaper, special-purpose automated devices. In short, the desire to "catch up" with the American "Shuttles" which our reader Beregoy was afraid of, played a cruel joke here.

In fact, Academician R. Sagdeyev attributes to the same factors the failure of the "Fobos" project, which cost our country R272 million, while foreign participants spent another 60 million on it. He says frankly that the reason for the failure should be sought in the actual organization of the project and its planning, and that under the burden of routine concerns we have lost control of the planning of cosmonautics. He goes on to admit: "Basically the USSR Academy of Sciences, and specifically our institute (and a number of others), is a client commissioning devices for carrying out fundamental research in space. The contractor, the producer of the work is the space industry in the shape of the USSR Ministry of General Machine Building. I am forced to observe that the relations that have grown up between the client and the contractor over many years of work are patently abnormal: We cannot yet regard ourselves as a fully functioning client, since we are totally dependent on the producer."

So a vicious circle is formed. The result of the fact that science and industry are losing their common language. The language that S.P. Korolev and M.V. Keldysh managed to find, despite the complexity of their relationship and characters.

Of course, cosmonautics has changed markedly since then. It has developed a great many ramifications. There are manned and automatic devices, devices for applied and fundamental research, for the study of near (near-earth) and distant space, and so forth. So what are we doing, rushing around in all directions on a trial and error basis?

It looks as if that is what we are trying to do—everything in small doses.

Yet it is well known how rewardingly space resources respond to an intelligently and purposefully formulated program. We have, for instance, a space communications system that has been operating efficiently for a long time, giving the country, and all of us, tangible technical and economic benefits. At the Malaga congress there was talk of how, in future, seats of human civilization could arise around the Earth, the Moon, and Mars, linked by interplanetary routes. Are we using the experience already accumulated to develop such projects?

...When each manned spacecraft goes into orbit, the crew always reports: "Pitch and yaw normal!" That means that the device's angles of deviation in various planes are in no danger of exceeding the set parameters. But is the pitch and yaw of space science normal? Furthermore, are we sending it into the right orbit, do we have the right strategic line to enable us to bring together our scattered avenues of space research and select the most important for the sake of general efficiency?

Let us study this on the basis of an example. In Malaga, L. Regel, scientific staffer at the Institute of Space Research, explained to me her conclusions on the organization of research in the sphere of space materials science. Combining this research with, say, astronomical observations has not been beneficial. While, for instance, a telescope requires the constant orientation of the spacecraft toward a given point, the processes taking place in weightlessness, on the other hand, react sensitively to the slightest acceleration of the spacecraft, which affects the level of microgravitation. Hence it came about that from mid-1987 through the end of 1989 only one-half of the trials on the "Kristallizator" equipment were completed.

So it goes on. Some firms manufacturing space devices are now claiming complete autonomy in drawing up experimental programs, on the basis of an exclusively commercial approach to their implementation. This means that in this particular instance, too, we are trying to punch with our fingers spread, instead of gathering them all into a single fist of fundamental research.

L. Regel draws the natural conclusion—it is expedient to create a single center for fundamental research in materials science and technology in different gravitational conditions, involving all interested institutions of the USSR Academy of Sciences and the country's industry, as well as foreign organizations. But if this is expedient for one highly promising sector of cosmonautics, it is all the more necessary for space science in general.

Alas, at the moment the movement is in the opposite direction. The Institute of Space Research has clearly not turned into a collective Chief Theorist, and by all appearances there is not much hope of it. The institute's staff, which has grown to an unmanageable size, is not integrating the living soul of cosmonautics, but dividing it up into separate sections commensurate with the interests of departments and laboratories. The functions of "Interkosmos," which until recently pursued fairly confidently the international cooperation among space specialists, have been distorted with the appearance of the USSR Main Administration for the Creation and Utilization of Space Technology, which pursues its own commercial line. Individual firms are increasingly laying claim to autonomous roles.

Initiative is no bad thing. But its "pitch and yaw" must also be kept on the right course. This can only be done by a single organization, a single scientific council defining the main areas of development of cosmonautics, and thence technical priorities. Such a council should include not only specialists in narrow fields, but also, without fail, philosophers, sociologists, and social scientists. It is a question of the future of mankind, the destiny of our civilization. There can be no such thing as technology that is indifferent to man and his concerns. Whatever distant reaches of space the most sophisticated space devices may travel, their guiding star should always be the flame of life that blazed up on the planet Earth.

Agreement on Launch of U.S. Satellites With Soviet Rockets

LD1611111689 Moscow TASS in English 0957 GMT 16 Nov 89

[Text] New York November 16 TASS—By TASS correspondent Yuriy Kirilchenko:

The first agreement on launching American satellites with Soviet rockets was concluded between the Space Commerce Corporation based in Houston, Texas, and the Soviet Chief Administration for the Development and Use of Space Engineering for the Economy and Research.

Under a contract worth 54 million dollars, Soviet booster rockets will put into orbit eight satellites of the Energetics Satellite Corporation based in Colorado.

The corporation plans to set up a world-wide satellite system to control freight traffic. The first launching will be made from the Baikonur Cosmodrome late next year.

According to Space Commerce President Arth Dula, who announced the deal, his corporation will tender an application for export licences in the near future.

He noted that cooperation with the USSR in civil space programs gives U.S. companies a chance to place space equipment into orbit more quickly.

However, there is still a large hurdle blocking the way of implementation of the Soviet-American program for peaceful uses of space. The concluded agreement has to be approved by Washington.

According to the present American laws on control over the export of modern technology, it is forbidden for U.S. satellites to be placed into orbit from the Soviet territory.

Comment on US-USSR Space Launch Ageement

LD1611233389 Moscow Television Service in Russian 1800 GMT 16 Nov 89

[From "Vremya" newscast]

[Excerpts] As the news agencies have stated today, the first agreement in history about the launch of U.S. satellites using Soviet rockets has been concluded between the Space Commerce Corporation and USSR Glavkosmos. Here is our commentary:

[Sergey Slipchenko] Here is the report. In accordance with a contract worth $54 million, Soviet carrier rockets are to take into near-earth orbit up to eight satellites belonging to the company Energetic Satellite Corporation. It plans to create a satellite system to regulate freight movement over the whole world. The first launch should take place at the end of next year from the Baykonur Cosmodrome. According to the words of (Art Dula), president of Space Commerce, who announced the deal, his corporation in the immediate future will apply for an export licence. I draw your attention to this report because it contains a small factual inaccuracy.

I first met (Art Dula) this summer in June at the air show at Le Bourget where he represented the Soviet space section of the air show—the Soviet section, because (Art Dula) had by then already been working with Glavkosmos for approximately 2 and ½ years; and his activity was, to put it mildly, not very serious, not very commercial. He dealt in special souvenirs, badges, symbolism and printed brochures. (Art) and I talked a lot. [passage omitted]

Today, on the eve of the meeting of Mikhail Sergeyevich Gorbachev and George Bush, there is exceptional interest in the Soviet Union among business circles in the United States of America. [passage omitted]

So this is how things work out: On the one hand, it is contantly said in the West that they emphasize and want to help our restructuring, including the economy. And, on the other hand, when mutually advantageous business deals have already been signed, then the existing law in the United States prohibits seeing them through to the end. Precisely such science-intensive, mutually advantageous contracts, specifically things which are rooted in scientific- technical progress, also may be a subject for discussion between the heads of the two states. Well then, the deals have been signed. Let us see how they will be carried out.

Dunayev Comments on Obstacles to Soviet-U.S. Space Cooperation

PM0412125389 Moscow SOVETSKAYA ROSSIYA in Russian 29 Nov 89 Single Edition p 6

[Interview with A. Dunayev, chief of the USSR Main Administration for the Creation and Utilization of Space Technology (Glavkosmos), especially for SOVETSKAYA ROSSIYA by TASS correspondent A. Filippov: "Satellites Waiting To Be Launched; Obstacles on the Path of Soviet-U.S. Cooperation in Space"—first two paragraphs are an introduction; place and date of interview not given]

[Text] As already reported, recently in the city of Houston (Texas) the first agreement in history was concluded to put into orbit, using "Proton" launchers, U.S. "Sat Trak" satellites belonging to the Energetic Satellite Corporation. If the U.S. State Department does not ban this deal, the company will pay $54 million under the contract.

It should be noted that the two countries' specialists fully realize that such cooperation is supremely mutually advantageous. But prevailing U.S. legislation on controlling the export of complex technology is still impeding dialogue between Soviet and U.S. specialists. Engineers and business people believe that this U.S. embargo is equally detrimental for U.S. and Soviet space colleagues.

[Dunayev] The thesis that Soviet space facilities are allegedly dependent on foreign technology is fundamentally inaccurate. Statements have often been made on this score, right up to the highest level. I can only repeat: This is clearly wishful thinking on the part of those who wish us ill. Soviet space rocket technology is in no way inferior to the best world models. The space age is 30 years old, and all this time the Soviet Union has been at the forefront of space exploration. Our latest achievement—the unique "Energiya" launcher—is being offered for commercial use. This rocket has proved itself, placing in orbit the "Buran" space vehicle which then completed an automatic landing.

[Filippov] The USSR Glavkosmos has already been in existence as a commercial organization for several years and, in spite of idle accusations about squandering national resources, brings in large sums in foreign currency for Soviet space exploration. What deals have been concluded "beyond the reach of" the U.S. Government and what have they given the sides participating in them?

[Dunayev] We are currently working with 35 countries. Within the framework of agreements on joint manned flights, each of them will bring in the region of $10 million to the Soviet side. In particular, the Soviet-Austrian space mission is coming soon, and the British "Juno" project. The news about the contract for a Japanese journalist to fly on board the "Mir" station produced a great response. Contracts are also expected with France and the FRG, and there have been preliminary talks with other countries...

What gains do the countries participating in manned flight as partners of the Soviet side expect? They would hardly start getting involved if it were unprofitable. Quite recently, for example, the Soviet-West German "Kozima-2" project ended successfully. A capsule from a "Resurs-F" spacecraft brought back to earth a unique consignment—more than 1,000 crystals of various substances to be used for pharmacological needs. Cooperation with FRG firms will continue: Four flights are planned for 1990, which will also bring considerable profit to both sides. In addition, we have found foreign firms which are ready to produce satellites with us without using U.S. technology—an embargo here will be pointless.

[Filippov] Can you give an approximate assessment of the losses incurred by the sides on account of the U.S. "embargo?"

[Dunayev] I am afraid this would take up a lot of space in the newspaper. Here are just a few examples. Last year the U.S. Congress did not give its consent to the launch from the Baykonur cosmodrome of two U.S. satellites made by the very large and well-known aerospace firm "Hughes" for international communications. If we had placed them in geostationary orbit, we would have had about $35 million for each launch. Alas...

Earlier a ban was placed on the launch of the "Inmarsat" satellite (maritime communications) by the firm "British Aerospace." Now it turns out that the satellites, whose price exceeds $100 million, are still lying in warehouses waiting their turn to be launched by "Ariane" or another launcher.

We are, of course, looking for ways to combat this hard line. It is proposed to build in the equatorial zone ranges where spacecraft will be launched into space using Soviet systems, including "Zenit" launchers—today one of the most sophisticated and ecologically clean rockets. Space means progress and the growth of peoples' well-being. And I cannot understand the U.S. Congress' position. Nor, incidentally, can U.S. business representatives with whom I happened to talk. In this connection I would like to recall that in 1987 N.I. Ryzhkov said that Soviet state organs would give their customers the necessary guarantees of safekeeping for their space devices. We are ready to exempt from customs inspection apparatus that is going to be launched and allow it to be transported through USSR territory to the cosmodrome in sealed containers—if this would be more convenient for the customer. Foreign specialists can accompany their equipment. They can be present during its transportation and its installation on the launcher, and be nearby right up to the launch itself.

First U.S. Experiment Aboard 'Mir'

LD0712103389 Moscow TASS in English 1018 GMT 7 Dec 89

[Text] New York December 7 TASS—By TASS correspondent Andrey Sitov:

In another sign of increasing superpower cooperation, the United States plans to carry out its first space research program aboard the Soviet Mir space station on December 20, according to Anthony Arrot, president of the U.S. Payloads System Company, who helped push through the idea.

This is a strictly commercial all-American venture, Arot told TASS, explaining that it was not a joint venture.

Payloads systems struck a deal with Soviet Licensintorg and Glavkosmos foreign trade firms to carry its payload into orbit on the Progress booster from the Baykonur launching paid in Soviet Kazakhstan, he said.

The experiment will take three months to complete. The Soviet space station was chosen precisely because of the duration of the research program—the Mir station is still the only permanent space lab in orbit, he said.

Preparations for the experiment were carried out during seven flights of U.S. space shuttles.

The experiments aim to grow protein crystals during prolonged periods of microgravitation, according to Payloads Systems. So far only several hundred out of thousands of existing proteins have been crystallised.

Microgravitation enables the crystallisation of more proteins, and the resulting crystals are bigger and have a better form, company officials said.

The research will offer many promising spin-offs for medicine, biotechnology, chemistry and metallurgy.

Payloads Systems is so far the only U.S. company with an export licence allowing it to conduct research on the Soviet space station.

The firm has already reserved six three-month-long periods on the space station during the next four years.

'Progress M-2' Carries U.S. Company's Experiment to 'Mir'

LD2312102289 Moscow Domestic Service in Russian 0000 GMT 21 Dec 89

[Text] As you know, comrades, on Wednesday Progress M-2, the second cargo spacecraft of a new series, was launched from the Baykonur cosmodrome. The list of the main cargoes that will be delivered to the orbiting complex is known to us from the flights of other Progress craft: water, foodstuffs, air, fuel, film and photographic materials, and instruments. But there is also something new: aboard the craft is a comparatively small U.S. installation for growing protein crystals. Thus, for the first time since the summer of 1975, when the "Soyuz-Apollo" experimental program was put into effect, space cooperation between the two countries was resumed.

True, at that time the flight was for the most part tackling tasks of detente rather than of science and commerce. Now however, business relations predominate. The Soviet side receives hard currency for putting the U.S. equipment into space and for subsequent experiments in space. After the flight, the container with the equipment will be returned to the U.S. company Payload Systems, which built it.

Let us note that, for the time being, the U.S. Congress has not lifted the embargo on the export of high technologies with regard to the Soviet Union. And even though many U.S. businessmen would like to make use of Soviet space facilities on a mutually advantageous basis for resolving the tasks of their firms, Payload Systems is, for the time being, the only company that has received an export licence.

Commentary on Soviet-French Meeting on Space Cooperation

PM0412135189 Moscow IZVESTIYA in Russian 24 Nov 89 Moscow Evening Edition p 5

[Yuriy Kovalenko dispatch under the "Correspondents Comment" rubric: "France-USSR: What's the Cost of a 'Space Ticket'?"]

[Text] Paris—In the opinion of specialists, this year proved extremely fruitful for Franco-Soviet space cooperation, and both countries are fully determined to continue it in the future. A third joint manned flight and a new program for Mars research are in prospect.

These two projects were examined at the annual—26th—Franco-Soviet meeting on space, which has just been held in the Pyrennean town of Saint-Jean-de-Luz. Commenting on this meeting, the Parisian press notes that the time of free flights for French crewmen on Soviet spacecraft is over. Henceforth, the newspapers write, France will have to pay $10 million per week for the "ticket."

The Soviet side, citing the fact that this is a "commercial secret," prefers not to discuss in public the cost of a seat on the craft. Those are indeed our rates now, a Soviet participant in the meeting confirmed, but there has as yet been no discussion of concrete figures with the French side. When we begin to consider figures, we will not, of course, fail to take into consideration the fact that our cooperation with France in the study of space began more than 20 years ago and has proved possible due to common efforts to achieve great scientific successes here.

"The French," Academician V.A. Kotelnikov, chairman of the "Intercosmos" Council, pointed out, "have invested hundreds of millions of francs in our joint programs. If we had not cooperated with them but had done everything ourselves, the space experiments would have been considerably less effective. By and large we have derived mutual advantage from this cooperation. Moreover, our joint work with French scientists has enabled us to make a critical assessment of our own program and elaborate a common viewpoint on the problem of developing space science."

Although cosmonauts and scientists are, of course, primarily interested in scientific rather than commercial and financial questions, the latter are also extremely important. For instance, budgetary constraints may prove a serious obstacle in the implementation of various projects.

In accordance with the summit accords, Soviet-French space studies are carried out within the framework of a 10-year program. In addition to joint flights, this makes provision, in particular, for study of the environment via satellite, medical and biological studies in space, and a number of other areas.

"We intend," V.A. Kotelnikov said, "to devote particular attention to three new areas of space study associated with our planet. They are study of the energies [energetika] and chemical composition of the earth's atmosphere (in particular, the ozone layer, by means of a laser), and last the influence of the earth's surface on energy transfer processes. Since 1966, when the first intergovernmental agreement on space was signed, a total of more than 60 joint projects have been implemented. Now virtually all research programs have become multilateral—that is, other states have joined with France and the Soviet Union.

"Whereas all the indications are that a new joint program linked with the study of Mars will begin in 1994, the launch of the 'Granat' Soviet artificial satellite is intended for 1 December this year. A telescope will be installed onboard to study X-rays. The studies conducted using this telescope will," Academician V.A.

Kotelnikov explained, "help clarify our notions of the properties of matter and, in particular, the universe."

As for a final agreement on a third joint space flight lasting approximately 14 days, it will be signed in a few weeks in Moscow. This flight will probably take place at the end of 1992.

Jean-Loup Chretien, who has twice taken part in joint voyages, has just been appointed adviser on manned flights to the president of France's National Space Research Center. He will head the detachment of French astronauts that is to be formed. But Michel Tonini, J.L. Chretien's understudy on the last flight, has the best chance of going into space today.

Soviet-French Space Agreement Signed

907Q0036 Moscow IZVESTIYA in Russian 23 Dec 89 p 12

[Article by S. Leskov: "A Road Into Space 10 Years Long"]

[Text] On 22 December in Moscow an agreement was signed between USSR Glavkosmos and the French National Center for Space Research on a long-term program of cooperation in the area of manned flights to the Soviet orbital complex.

A cosmonaut from France has already worked twice aboard Soviet orbital stations; on both occasions it was Jean-Loup Chretien. The research performed has significantly enriched space science and its mutual benefits have been apparent. However, the previous flights were arranged as one-time agreements and the lack of a long-term perspective impeded cooperation. Now an agreement has been reached on a long-term program of joint research designed for a period of ten years. This program was signed by A. Dunayev, chief of USSR Glavkosmos, and J.-M. Luton, director general of CNES. The first joint flight has already been set for 1992; it will be approximately two weeks long. In all, it is proposed that over the ten year period there will be five Soviet-French expeditions.

Specific details for the upcoming projects will be coordinated by the recently declassified "Korolev" KB [design bureau], now known as NPO "Energiya" and headed by corresponding member of the USSR Academy of Sciences Yu. Semenov. Schedules will be determined in accordance with crew training, equipment and financial capacities.

The entire program of research should bring substantial profit to the national economy since, as distinct from the earlier flights, it is arranged on commercial basis. In this connection it has been specified that disputed questions may be decided by international arbitration.

French Minister Comments on Space Agreement

LD2712204389 Moscow TASS in English 1801 GMT 27 Dec 89

[Text] Paris December 27 TASS—By TASS correspondent Vladimir Shvets: The French National Space Studies Centre (CNES) and the USSR Chief Administration for the Development and Use of Space Engineering for the Economy and Research (Glavkosmos) have signed an agreement on the organization of the third Soviet-French space flight.

Under the agreement, a French astronaut will spend 12 days aboard the Soviet space station Mir. The program of the mission, planned for 1992, envisages research in the field of medicine, basic physics and technology, specifically, into semiconductor crystallization in zero-gravity conditions.

Commenting on the signing of the agreement, French Minister of Postal Services, Telecommunications and Space Paul Quiles said in an interview with the newspaper LE FIGARO that Soviet-French cooperation in space exploration gives French specialists a unique opportunity to gain experience in solving problems related to man's stay beyond the boundaries of our planet. This is of particular interest to France in view of the program of building a space shuttle Hermes. Besides, man's flights into space are important from the point of view of science, including for research in biology and space medicine.

Quiles noted that Soviet-French cooperation in space research, which started in 1966, has already yielded considerable results which found application in accomplishing purely earthly tasks, for instance, to develop new medicines. Joint experiments in space are of mutual interest and the new flight will not become an exception in this sense. Both French and Soviet scientists will be able to make use of the results of the French astronaut's work aboard the Mir, Quiles noted.

French Cosmonaut To Work Aboard Mir Station in 1992

LD1701190690 Moscow TASS in English 1850 GMT 17 Jan 90

[Text] Paris January 17 TASS—A French cosmonaut will make a 12-day space flight on board the Soviet orbital space station Mir in 1992, Paul Quiles, french minister of communications and space, said here today.

The space expedition, Antares, will enable French specialists to conduct various experiments in space medicine, psychology and biology, official government spokesman Louis le Pensec said. According to Louis le Pensec, part of the overall sum of 80 million francs needed to prepare and conduct the flight will be donated by the French National Center of Space Studies. Usually the cost of such flights is about twice as high. This will be donated by the French National Center of Space Studies. This is why the agreement concluded with the USSR is evidence of "privileged relations with the USSR," he pointed out.

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